Draft Quality Assurance Project Plan for Sediment Erosion Rate Measurements in the Newark Bay Study Area

Prepared by:

Sea Engineering, Inc.
The Louis Berger Group, Inc.

September 2012

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FIGURES

ATTACHMENTS

QAPP Worksheet 1
Title and Approval Page

Site Name/Project Name: Newark Bay Study Area RI/FS Oversight (NJD980528996)
Site Location: New Jersey
Operable Unit: OU-03

Document Title: Quality Assurance Project Plan for Sediment Erosion Rate Measurements in the Newark Bay Study Area

Lead Organization: USEPA Region 2

Preparer's Name and Organizational Affiliation:
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Preparation Date (Day/Month/Year): September 13, 2012

Investigative Organization's
Task Leader:

_____
Jason Magalen, Sea Engineering, Inc.

Investigative Organization's
Site Quality Control Officer:

_____
AmyMarie Accardi-Dey, The Louis Berger Group, Inc.

Lead Agency's Project Manager (Approval Authority):

_____
Eugenia Naranjo, USEPA

QAPP Worksheet 2
QAPP Identifying Information

Site Name/Project Name: Newark Bay Study Area RI/FS Oversight
Site Location: Essex County, New Jersey
Site Number/Code: NJD980528996
Operable Unit: OU-03
Contractor Name: The Louis Berger Group, Inc.
Contract Number: W912DQ-11-D-3009
Contract Title: Indefinite Delivery/Indefinite Quantity Type Contract for Miscellaneous Military and Civil Hazardous Waste Cleanup Projects and Related Work
Work Assignment Number: Task Order 0006

Title: Quality Assurance Project Plan for Sediment Erosion Rate Measurements in the Newark Bay Study Area
Revision Number: not applicable
Revision Date:

1. Identify regulatory program:
   Comprehensive Environmental Response, Compensation, and Liability Act.
   QAPP prepared following the "Uniform Federal Policy (UFP) for Quality Assurance Project Plans" (USPEA Document No. 505-B-04-900A, Final Version 1. March 2005).

2. Identify approval entity: USEPA Region 2

3. The QAPP is (select one): ☐Generic ☒Project Specific

4. List dates of scoping sessions: refer to Worksheet 9

5. List dates and titles of QAPP documents written for previous site work, if applicable:

Title	Approval Date
Malcolm Pirnie, Inc. 2006. "Field Sampling Plan, Volume 1." Lower Passaic River Restoration Project. Prepared for USEPA and USACE. January 2006.	January 2006
HDR|HydroQual, Inc. 2006. "Final Modeling Work Plan." Lower Passaic River Restoration Project. Prepared for USEPA and USACE. September 2006.	September 2006
HDR|HydroQual, Inc. 2006. "Final Modeling Work Plan Addendum." Newark Bay Study Area. Prepared for USEPA and USACE. September 2006.	September 2006
Sea Engineering, Inc. "Field Modification Form for SEDflume Consolidation Analysis." Lower Passaic River Restoration Project. Prepared for USEPA and USACE. October 2008.	October 2008

6. List organizational partners (stakeholders) and connection with lead organization:
   - The U.S. Army Corps of Engineers (USACE), Kansas City District performs contract management for U.S. Environmental Protection Agency (USEPA) Region 2 on both the Newark Bay Study Area (NBSA) Remedial Investigation/Feasibility Study (RI/FS) Oversight and Lower Passaic River Restoration Projects. Newark Bay is an operable unit of the Diamond Alkali Superfund Site on the Lower Passaic River.
   - The Louis Berger Group, Inc. (LBG) provides consulting services under contract to USACE on the Newark Bay Study Area RI/FS Oversight Project. Battelle and HDR|HydroQual, Inc. (HDR|HQI) are team sub-consultants for The Louis Berger Group, Inc. Sea Engineering, Inc. (SEI) is a subcontractor to HDR|HQI. CDM Smith, Inc. provides consulting services for the oversight portion of the Lower Passaic River Restoration Project.
   - Tierra Solutions, Inc. (TSI) manages the RI/FS in the Newark Bay Study Area with their contractor ARCADIS. The Cooperating Parties Group (CPG) retained de maximis, inc. to manage the RI/FS on the Lower Passaic River. AECOM and Windward Environmental LLC are implementing the Lower Passaic River RI/FS under de maximis, inc.'s oversight and direction. The CPG manages the hydrodynamic and sediment transport model for both the NBSA and Lower Passaic River.

7. List data users:
   Partner Agencies [USEPA, USACE, New Jersey Department of Environmental Protection (NJDEP), U.S Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA)], LBG, Battelle,

HDR|HQI, SEI, CDM Smith, CPG, TSI, and other project stakeholders.

8. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusions below: NONE.

QAPP Worksheet 3
Distribution List

Distribution List (Worksheet 3)

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address	Document Control Number
Eugenia Naranjo	USEPA Project Manager (Newark Bay Study Area RI/FS Oversight)	USEPA, Region 2	212-637-3467	naranjo.eugenia@epa.gov	Electronic Version of NB001
Stephanie Vaughn	USEPA Project Manager (Lower Passaic River Restoration Project – RI/FS Oversight)	USEPA, Region 2	212-637-3914	vaughn.stephanie@epa.gov	Electronic Version of NB001
Alice Yeh	USEPA Project Manager (Lower Passaic River Restoration Project)	USEPA, Region 2	212-637-4427	yeh.alice@epa.gov	Electronic Version of NB001
Elizabeth Buckrucker	USACE Project Manager	USACE, Kansas City District	816-389-3581	elizabeth.a.buckrucker@usace.army.mil	Electronic Version of NB001
Len Warner	Project Manager (Newark Bay Study Area RI/FS Oversight)	LBG	914-798-3721	lwarner@louisberger.com	Electronic Version of NB001
Jason Magalen	SEDflume Task Leader (Newark Bay Study Area RI/FS Oversight and Lower Passaic River Restoration Project)	SEI	541-740-3715	jmagalen@seaengineering.com	Electronic Version of NB001
AmyMarie Accardi-Dey	Site Quality Control Officer (Newark Bay Study Area RI/FS Oversight)	LBG	914-798-3712	aaccardidey@louisberger.com	Electronic Version of NB001
Edward Garland	Modeling Project Manager (Newark Bay Study Area RI/FS)	HDR|HQI	201-529-5151	edward.garland@hdrinc.com	Electronic Version of NB001
James Wands	Modeling Project Manager (Lower Passaic River Restoration Project)	HDR|HQI	201-529-5151	james.wands@hdrinc.com	Electronic Version of NB001
Frank Tsang	Project Manager (Lower Passaic River Restoration Project – RI/FS Oversight)	CDM Smith	212-377-4056	tsangc@cdmsmith.com	Electronic Version of NB001

Distribution List (Worksheet 3)

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address	Document Control Number
Field Team Members To Be Determined		Sea Engineering, Inc.			Electronic Version of NB001

QAPP Worksheet 4
Project Personnel Sign-Off Sheet

Project Personnel Sign-Off Sheet (Worksheet 4)

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Eugenia Naranjo	USEPA Project Manager	212-637-3467		
Len Warner	Project Manager	914-798-3721		
AmyMarie Accardi-Dey	Site Quality Control Officer	914-798-3712		
Edward Garland	Modeling Project Manager	201-529-5151		
Jason Magalen	SEDflume Task Leader	541-740-3715		

QAPP Worksheet 5
Project Organization Chart

Refer to the Project Organization Chart attached in Figure 1.

QAPP Worksheet 6
Communication Pathways

Communication Pathways (Worksheet 6)

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Approval of amendments to the QAPP	LBG SEI	Site Quality Control Officer with SEDflume Task Leader approval	914-798-3712 541-740-3715	Obtain initial approval from SEDflume Task Leader. Submit documented amendments within 10 working days for transmittal to USACE and USEPA for approval.
Document control	LBG	Project Manager	914-798-3721	Project document distribution to USACE and USEPA for review and approval.
Stop work and initiation of corrective action	LBG	Project Manager	914-798-3721	The Project Manager communicates within 24 hours of stop work to the project organization by phone with confirming e-mail.
Real time modification, notifications and approval	LBG SEI	Site Quality Control Officer with SEDflume Task Leader approval	914-798-3712 541-740-3715	Real time modification to the project will require the approval of the Site Quality Control Officer and SEDflume Task Leader and will be documented using a Field Modification Form within 10 working days.
Reporting of serious issues	LBG	Project Manager SEDflume Task Leader	914-798-3721 541-740-3715	Field Team Members will report serious issues to the SEDflume Task Leader, who will communiceate them to the Project Manager. The Project Manager will report any serious issues to the USEPA and USACE and other concerned parties by phone or e-mail.
Corrective action and audit finding	LBG	Site Quality Control Officer	914-798-3712	Problems or negative audit findings are reported to the Project Manager by e-mail within 10 working days.
Field communication	SEI	SEDflume Task Leader	541-740-3715	Communicate with staff in the field to coordinate field work and collection of field samples. Summarize daily activity in electronic mail format to Project Manager.
Field communication with the USEPA and USACE	LBG SEI	Project Manager SEDflume Task Leader	914-798-3721 541-740-3715	As necessary, communicate with the USEPA and USACE on observations made during field work.
Communication with laboratories	SEI	SEDflume Task Leader	541-740-3715	Communicate with SEI (in-house laboratory) to address any analytical issues. The SEDflume Task Leader will communicate with the Site Quality Control Officer on any analytical issues that arise.

QAPP Worksheet 7
Personnel Responsibilities and Qualification Table

Personnel Responsibilities and Qualification Table (Worksheet 7)

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Beth Buckrucker	USACE Project Manager	USACE, Kansas City District	USACE Project Manager	NA
Eugenia Naranjo	USEPA Project Manager	USEPA, Region 2	USEPA Project Manager	NA
Len Warner	LBG Project Manager	LBG	Investigative Organization Project Manager	BSE Engineering, 22+ years of experience in Environmental Engineering, specifically contaminated site investigation and remedial planning.
AmyMarie Accardi-Dey	Site Quality Control Officer	LBG	Site Quality Control Officer	PhD Environmental Engineering/Chemical Oceanography, 8+ years of experience in Environmental Engineering, specifically analytical chemistry and contaminated site investigation and remedial planning.
Edward Garland	Modeling Project Manager	HDR|HQI.	Review sediment transport model parameterization	ME Environmental Engineering, 30+ years of modeling experience.
Jason Magalen	SEDflume Task Leader	SEI	Conduct erosion rates study	PE, CH in Coastal/Ocean Engineering, 8+ years experience in surveying, data collection and analysis, and modeling.

Resumes and copies of certifications are on file at the LBG office in Elmsford, New York; HDR|HQI office in Mahwah, New Jersey; and SEI office in Santa Cruz, California.

QAPP Worksheet 8
Special Personnel Training Requirements Table

Special Personnel Training Requirements Table (Worksheet 8)

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
SEDflume field and analytical team and site visitors for erosion rate testing	Safety and OSHA training as specified in the Health and Safety Plan[1]	SEI HDR|HQI LBG	Training dates kept in company/project training records	All field team members working on-site	SEI SEDflume Field and Analytical Team HDR|HQI (visitor) LBG (visitor)	Training records are on file at the LBG office in Elmsford, New York; HDR|HQI office in Mahwah, New Jersey; and SEI office in Santa Cruz, California

1: The Site-Specific Health and Safety Plan (dated September 2012) will be provided to the USEPA and the USACE under separate cover.

QAPP Worksheet 9
Project Scoping Session Participants Sheet

Project Scoping Session Participants Sheet (Worksheet 9)

Project Name: Quality Assurance Project Plan for Sediment Erosion Rate Measurements in the Newark Bay Study Area **Projected Date(s) of Sampling**: October 2012 **Project Manager**: Eugenia Naranjo (USEPA) Elizabeth Buckrucker (USACE) Len Warner (LBG)	**Site Name**: Newark Bay Study Area RI/FS Oversight **Site Location**: New Jersey
Date of Session: 28 August 2012 Scoping Session Purpose: Discuss scoping and data quality objectives of a field program to measure erosion rates in the Newark Bay.	

Name	Title	Affiliation	Phone #	E-mail Address
Eugenia Naranjo	USEPA Project Manager	USEPA	212-637-3467	naranjo.eugenia@epa.gov
Edward Garland	Modeling Project Manager	HDR|HQI	201-529-5151	edward.garland@hdrinc.com
Jason Magalen	SEDflume Task Leader	SEI	541-740-3715	jmagalen@seaengineering.com

Comments/Decisions and Action Items:

- Established the number of cores to be collected for SEDflume analysis.
- Established the number of grab samples to be collected and slurry consolidation cores to be prepared for SEDflume analysis.
- Included the collection of deep water cores from the navigation channel in the erosion rates testing program.
- Discussed logistics for SEDflume core processing and staging (80 Lister Avenue site), water storage tanks, electrical power and water supply needs.
- Discussed anticipated project schedule.

QAPP Worksheet 10
Problem Definition

Problem Definition (Worksheet 10)

The problem to be addressed by the project:
As described in the Administrative Order on Consent (AOC) between the USEPA and the Occidental Chemical Corporation (a successor to the Diamond Alkali Company) dated February 17, 2004, remedial investigation activities for Newark Bay were determined to be necessary to characterize the areal extent of contamination associated with the Diamond Alkali Superfund Site (OU-01) located on the Lower Passaic River in Newark, New Jersey. Since the Lower Passaic River and Newark Bay are hydrologically-linked waterbodies, the RI/FS for the Newark Bay Study Area (also referred to as OU-03 of the Diamond Alkali Superfund Site) will be conducted consistently with the CERCLA and SARA components of the Lower Passaic River Restoration Project (also referred to as OU-02 of the Diamond Alkali Superfund Site). Tierra Solutions, Inc. (TSI), on behalf of Occidental Chemical Corporation, contracted ARCADIS to conduct the RI/FS in the Newark Bay Study Area. In September 2009, the USEPA issued General Notice Letters to companies considered potentially responsible for the historical releases of hazardous substances of concern to the Newark Bay Study Area, including tributaries other than the Lower Passaic River. The RI/FS effort for the lower 17.4 miles of the Passaic River is being conducted by the CPG, which represents the 73 companies that signed the AOC with the USEPA on May 8, 2007 and are considered potentially responsible for the contamination in the Lower Passaic River. The CPG has retained the consultants de maximis, inc., AECOM, and Windward Environmental LLC to support them in the RI/FS effort. The RI/FS and CPG field programs are being closely monitored by the USACE and USEPA. LBG provides consulting services under contract to USACE on the Newark Bay Study Area RI/FS Oversight Project. Battelle and HDR|HQI (and their subcontractor – SEI) are team sub-consultants for LBG.

The CPG is currently developing a hydrodynamic and sediment transport numerical model for the Lower Passaic River and Newark Bay. Model development, verification, calibration, and output are being overseen by the USACE, USEPA, and their contractors. Site-specific sediment erosion properties of Newark Bay sediments are needed to support the modeling being performed by the CPG. To date, model parameterization of erosion properties in Newark Bay has been based on erosion measurements from Lower Passaic River sediments collected in 2005; however, these erosion properties exhibited substantial, unexplained, small-scale and large-scale spatial variability, which may not be representative of Newark Bay sediments. A sediment sampling and erosion measurement project is being implemented by USEPA to evaluate sediment erosion properties and their variability in Newark Bay using replicate samples from several locations, which were selected based on particle size distributions, modeled shear stress intensities, spatial location within the Bay, geomorphological categorization (based on 2006 USACE characterization), and locations where chemicals of potential concern (COPCs) have been identified. Understanding the Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts.

The environmental questions being asked:
USEPA is implementing a sediment sampling and erosion measurement project to sediment erosion properties and their variability in Newark Bay using replicate samples at several locations. Understanding the variability of Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts. The USEPA field program will consist of:

- In-field SEDFlume testing of 24 cores (12 locations x 2 proximal cores from each location = 24 cores) collected from Newark Bay to evaluate the (*in-situ*) downcore erosion properties of bay sediments. *Data Quality Objective: Analyzing pairs of proximal cores will assess whether small-scale erosion rate variation exists between cores and will yield information on possible bay-wide sediment erosion rate variation. These data will provide initial guidance on (1) developing a sediment transport model from a spatial separation standpoint (i.e., should sediment erosion rate data from one side of Newark Bay be extrapolated and used in other areas of the bay), (2) characterizing variability in downcore erosion rates among proximal cores, and (3) determining if this downcore variability is common to all or select sediment cores that were collected and examined.*
- Laboratory SEDFlume testing of 25 consolidated slurry cores (5 locations × 5 slurry cores = 25 cores plus quality control samples) prepared using surface sediment, consisting of the top 15-30 cm of material (collected via grab sampling) in Newark Bay. Consolidation periods will include 1, 4, 7, 14, and 28 days (generating 5 consolidated slurry cores per sampling location). *Data Quality Objective: Sediment transport modeling requires information on the behavior of sediments during consolidation to accurately describe*

Problem Definition (Worksheet 10)

changes in erosion behavior with time, as consolidation occurs. The erosion rates measured from intact field cores are often insufficient to constrain the model representation of consolidation processes.

Observations from any site reconnaissance reports:
Observations from and data generated by sediment coring field work conducted by TSI in Newark Bay in 2005 and 2007 was used to inform the design of the erosion rates testing program.

A synopsis of secondary data or information from site reports:
- USACE sediment erosion rate measurements (SEDFlume) from sediment cores collected in the Lower Passaic River (2005).
- Contaminant concentration and physical properties data from TSI sediment coring programs in the Newark Bay Study Area in 2005 (Phase 1) and 2007 (Phase 2).

The possible classes of contaminants and the affected matrices:
Not applicable to erosion rates testing.

The rationale for inclusion of chemical and nonchemical analyses:
Sediment bulk properties are being measured to evaluate SEDFlume erosion rates. Each sediment core (field collected and laboratory slurry core) will be analyzed via SEDFlume to estimate erosion rate. Understanding Newark Bay sediment erosion properties and their variability will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts. Sediment erosion core samples will be analyzed for the following bulk property parameters:
- Bulk density
- Water content
- Particle size distribution using laser diffraction
- Loss on ignition (LOI)

Project decision conditions ("If..., then..." statements):
Decisions regarding the use of the SEDflume data and findings during model parameterization are outside of the scope of this QAPP.

QAPP Worksheet 11
Project Quality Objectives/Systematic Planning Process Statements

Project Quality Objectives /Systematic Planning Process Statements (Worksheet 11)

Who will use the data?
Partner Agencies (USEPA, USACE, NJDEP, USFWS, and NOAA), LBG, CDM Smith, Battelle, HDR|HQI, TSI, CPG, and stakeholders (as necessary).

What will the data be used for?
USEPA is implementing a sediment sampling and erosion measurement project to evaluate sediment erosion properties in Newark Bay. Small-scale variability will be evaluated by testing replicate samples at several locations. Understanding the variability of Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts.

What type of data is needed?
Erosion rates (calculated as a function of shear stress and depth in the sediment core) will be estimated using a Sediment Erosion and Deposition Flume (SEDFlume). (Refer to the following reference on SEDFlume methods: McNeil J, Taylor C, and Lick W, 1996, *Measurements of Erosion of Undisturbed Bottom Sediments with Depth*, J. Hydraulic Engineering, 122(6) pp. 316-324.) This flume is a long (2 m), narrow (10 cm), and thin (2.5 cm) instrument that allows water to flow across a sediment surface at a prescribed flow rate. Field sediment cores or laboratory consolidated slurry cores (approximately 60 cm in length) are introduced to the flume in a rectangular (in cross-section) core barrel. The core is loaded into the flume from beneath, with the surface sediment exposed to the water that is flowing in the flume. As sediments are eroded (via applied, near-bed grain shear stresses) from the surface, the remaining core material is raised in height by the analyst using a jack so that the sediment surface level is maintained flush with the bottom of the flume. This technique simulates the erosive forces that would act solely on the surface sediment. Erosion rates are calculated as vertical loss of sediment per unit time. Erosion rates are calculated by measuring the remaining core length at different time intervals, taking the difference between each successive measurement, and dividing by the time interval. (Sediment cores can be moved at intervals as small as 0.5 mm.)

Supplemental sediment bulk parameters will be measured on each field-collected sediment core and laboratory-prepared consolidation core. Bulk parameters include: bulk density, water content, particle grain size distribution, and LOI.

How "good" do the data need to be in order to support the environmental decision?
Refer to Worksheet 12, Worksheet 15, and Worksheet 28, which summarize data quality (including measurement performance, project quantitation limits, and quality control measures for each parameter).

How much data are needed? (number of samples for each analytical group, matrix, and concentration)
The USEPA field program will consist of:

- In-field SEDFlume testing of 24 cores (12 locations x 2 proximal cores from each location = 24 cores) collected from Newark Bay to evaluate the (*in-situ*) downcore erosion properties of bay sediments. *Data Quality Objective: Analyzing pairs of proximal cores will assess whether small-scale erosion rate variation exists between cores and will yield information on possible bay-wide sediment erosion rate variation. These data will provide initial guidance on (1) developing a sediment transport model from a spatial separation standpoint (i.e., should sediment erosion rate data from one side of Newark Bay be extrapolated and used in other areas of the bay), (2) characterizing variability in downcore erosion rates among proximal cores, and (3) determining if this downcore variability is common to all or select sediment cores that were collected and examined.*
- Laboratory SEDFlume testing of 25 consolidated slurry cores (5 locations × 5 slurry cores = 25 cores plus quality control samples) prepared using surface sediment, consisting of the top 15-30 cm of material (collected via grab sampling) in Newark Bay. Consolidation periods will include 1, 4, 7, 14, and 28 days (generating 5 consolidated slurry cores per sampling location). *Data Quality Objective: Sediment transport modeling requires information on the behavior of sediments during consolidation to accurately describe*

changes in erosion behavior with time, as consolidation occurs. The erosion rates measured from intact field cores are often insufficient to constrain the model representation of consolidation processes.

Where, when, and how should the data be collected/generated?
Where: Newark Bay Study Area (refer to Worksheet 18 for sampling locations)
When: October 2012
How: SEDFlume studies using field-collected sediment cores will be performed by SEI at a nearby, off-site facility (80 Lister Avenue, Newark, NJ). SEDFlume studies using laboratory-consolidated slurry cores will be performed by SEI at their Santa Cruz facility. Bulk properties of sediment samples will be analyzed by SEI at their in-house laboratory.

Who will collect and generate the data?
SEI (subcontractor to HDR|HQI) field staff will collect sediment cores and sediment samples. SEI will conduct SEDFlume studies, measure sediment bulk properties, and calculate erosion rates. Refer to Worksheet 19 for container information and refer to Worksheets 26 and 27 for shipment information.

How will the data be reported?
Data reporting will include:
- Photographs of the cores prior to analysis.
- Plots and tables of the measured sediment bulk properties (refer to Worksheet 12 for bulk density, water content, and erosion rate formulas).
- Plots and tables of the down-core measured erosion rates.
- The computed critical shear stresses of the sediment core. The critical shear stress will be computed using a linear method and a power law regression fit (refer to: Roberts, J., Jepsen, R., and Lick, W., 1998, *Effects of Particle Size and Bulk Density on the Erosion of Quartz Particles*, J. Hydraulic Engineering, 124(12) pp. 1261-1267.)

Erosion rates, critical shear stresses, and sediment bulk properties will be provided to the USEPA and USACE via a report deliverable. The analytical data will be reported according to the requirements in Worksheet 29. Non-chemical laboratory data (bulk density, water content, LOI, and particle size distribution) produced by SEI laboratories will be verified by SEI Quality Assurance Officer and Site Quality Control Officer. Data verification is described in Worksheets 34, 35, and 36.

How will the data be archived?
Analytical data and scans of field forms and notes (core logs and data sheets) will be kept in LBG, HDR|HQI, and SEI project files. Hard-copies of field forms and field notes will be maintained in SEI's offices. Electronic data will be provided to the Partner Agencies as a PDF report deliverable, which will also be uploaded to the project Sharepoint site for stakeholder accessibility. The length of time that records will be archived will be at the discretion of the USACE and USEPA.

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	Bulk Density
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	Sensitivity	MDL defined per SEI Laboratory SOP	Detection limit	A
		Sensitivity	Zero ±0.0003 grams (checked daily)	Balance Tare	A
		Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard (checked daily)	Laboratory Control Sample	A
		Accuracy	<1% loss in mass with drying at 110±5 degrees Celsius for minimum of 12 hours	Constant Dry Mass	A
		Precision	RPD ≤ 20% for the three analytical runs; results represent the average	Laboratory replicate	A
		Precision	RPD ≤ 40% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data review	A

Bulk Density (g/cm^3) = $\rho_b = \frac{\rho_w \rho_s}{\rho_w + (\rho_s - \rho_w)W}$ where ρ_b = bulk density, ρ_w = density of water (assume constant at 1.00 g/cm^3), ρ_s = density of solids (assume constant at 2.65 g/cm^3), and W = water content (percentage).

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	Water Content
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	Sensitivity	MDL defined per SEI Laboratory SOP	Detection limit	A
		Sensitivity	Zero ±0.0003 grams (checked daily)	Balance Tare	A
		Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard (checked daily)	Laboratory Control Sample	A
		Accuracy	<1% loss in mass with drying at 110±5 degrees Celsius for minimum of 12 hours	Constant Dry Mass	A
		Precision	RPD ≤ 20% for the three analytical runs; results represent the average	Laboratory replicate	A
		Precision	RPD ≤ 40% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data review	A

Water Content (unitless) = $W = \frac{M_w - M_d}{M_w}$ where W = water content, M_w = wet weight of sample, M_d = dry weight of sample.

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	Particle Size
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2	Sensitivity	MDL defined per SEI Laboratory SOP (99% confidence level)	Detection limit	A
		Sensitivity	≤ QL (flush instrument with clean tap water)	Method blank	A
		Accuracy	As stipulated by manufacturer (frequency: every hour)	Laboratory Control Sample (35 micron particle)	A
		Precision	RPD ≤ 1% for the three analytical runs; results represent the average	Laboratory replicate	A
		Precision	RPD ≤ 50% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S & A
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data review	A

1: Prior to conducting particle size analysis, samples shall be (1) sieved through a 2,000 µm sieve (if necessary) and (2) negatively charged clay particles will be dispersed through a sonification process.

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	LOI
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	ASTM D2974 Version C	Sensitivity	MDL defined per ASTM D2974 Version C	Detection limit	A
		Sensitivity	Zero ±0.0003 grams (checked daily)	Balance Tare	A
		Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard (checked daily)	Laboratory Control Sample	A
		Accuracy	<1% loss in mass with drying at 440±22 degrees Celsius for minimum of 1 hour	Constant Dry Mass	A
		Precision	RPD ≤ 20% for the three analytical runs; results represent the average	Laboratory replicate	A
		Precision	RPD ≤ 40% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data review	A

Organic Matter (percentage) = 100 – (C × 100)/B where C = mass of sample after combustion and B = mass of oven-dried sample (not combusted)

Method detection limit is 0.01 grams on gravimetric weight and results reported to 0.1%

QAPP Worksheet 12
Measurement Performance Criteria

Matrix	Sediment
Analytical Group	Erosion Rate
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field Sampling: SOP No. 1	SEI Laboratory SOP "SEDFlume" September 2012, Revision 1.0	Accuracy/Sensitivity	Flow meter checked daily; measured flow rates ±20% of recorded flows	Flow rates	A
		Accuracy/Sensitivity	Jack movement ≥ 0.5 mm	Jack movement	
		Accuracy	10^{-4} cm/s (which represents 1 mm of erosion in approximately 15 minutes)	Critical shear stress	A
		Precision	RPD ≤ 50% for consolidated slurry cores	Field duplicate	S
		Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores	Data quality assessment	S
		Completeness	≥ 95% complete	Data quality assessment	S & A
		Comparability	Comparable units, QLs, and methods	Data quality assessment	S & A
		Comparability	Detection limits meet project goals	Data Review	A

1: Erosion Rate = $\Delta z/T$ where Δz = amount of sediment eroded and T = time. Erosion rates are calculated as vertical loss of sediment per unit time. Erosion rates are calculated by measuring the remaining core length at different time intervals, taking the difference between each successive measurement, and dividing by the time interval. (Sediment cores can be moved upwards into the flume at intervals as small as 0.5 mm.)

QAPP Worksheet 13
Secondary Data Criteria and Limitations Table

Secondary Data Criteria and Limitations Table (Worksheet 13)

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
2005 USACE Lower Passaic River Erosion Rates	USACE 2006. "ERDC-TR-06-7: Erodibility Study of Passaic River Sediments using USACE Sedflume." September 2006.	USACE	Erosion rate and critical shear stresses will be used in the modeling of Lower Passaic River sediment beds.	USACE 2005 dataset does not contain erosion rates and critical shear stresses for Newark Bay sediments but was reviewed for information pertinent to Newark Bay study design.
2005 and 2007 TSI Sediment Coring	TSI 2005. "Newark Bay Study Area RIWP, Sediment Sampling and Source Identification Program, Phase I." Revision 1, September 2005. TSI 2007. "Newark Bay Study Area Remedial Investigation Work Plan (RIWP), Sediment Sampling and Source Identification Program, Phase II." Revision 2, Amendment 1, November 2007.	TSI	Surface sediment chemistry concentrations and physical parameters were used to identify coring locations for SEDFlume testing.	TSI 2005 and 2007 datasets do not contain data on sediment erosion rates.

QAPP Worksheet 14
Summary of Project Tasks

Summary of Project Tasks (Worksheet 14)

Sampling Tasks:
USEPA is implementing a sediment sampling and erosion measurement project to evaluate variability of sediment erosion properties in Newark Bay using replicate samples at several locations. Understanding the variability of Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts. The USEPA field program will consist of:

- In-field SEDFlume testing of 24 cores (12 locations x 2 proximal cores from each location = 24 cores) collected from Newark Bay to evaluate the (*in-situ*) downcore erosion properties of bay sediments. *Data Quality Objective: Analyzing pairs of proximal cores will assess whether small-scale erosion rate variation exists between cores and will yield information on possible bay-wide sediment erosion rate variation. These data will provide initial guidance on (1) developing a sediment transport model from a spatial separation standpoint (i.e., should sediment erosion rate data from one side of Newark Bay be extrapolated and used in other areas of the bay), (2) characterizing variability in downcore erosion rates among proximal cores, and (3) determining if this downcore variability is common to all or select sediment cores that were collected and examined.*
- Laboratory SEDFlume testing of 25 consolidated slurry cores (5 locations × 5 slurry cores = 25 cores plus quality control samples) prepared using surface sediment, consisting of the top 15-30 cm of material (collected via grab sampling) in Newark Bay. Consolidation periods will include 1, 4, 7, 14, and 28 days (generating 5 consolidated slurry cores per sampling location). *Data Quality Objective: Sediment transport modeling requires information on the behavior of sediments during consolidation to accurately describe sediment deposition and associated changes in erosion behavior. The erosion rates measured from intact field cores are often insufficient to constrain the model consolidation physics.*

Refer to Worksheet 17 for sampling details; Attachment 2 for Field SOPs; and Attachment 3 for Analytical SOPs.

Analysis Tasks:
SEI will conduct SEDFlume studies, measure sediment bulk properties (bulk density, water content, particle size distribution, and LOI), and calculate erosion rates. Refer to Worksheet 12, Worksheet 15, and Worksheet 28, which summarize data quality (including measurement performance, project quantitation limits, and quality control measures for each parameter).

Quality Control Tasks:
SEI will conduct SEDFlume studies, measure sediment bulk properties (bulk density, water content, particle size distribution, and LOI), and calculate erosion rates. Refer to Worksheet 12, Worksheet 15, and Worksheet 28, which summarize data quality (including measurement performance, project quantitation limits, and quality control measures for each parameter).

Secondary Data:
Refer to Worksheet 13 for Secondary Data (data source and limitation on data use).

Data Management Tasks:
Refer to Worksheet 29 for discussion of data management.

Documentation and Records:
Refer to Worksheet 11 for discussion on documentation records.

Summary of Project Tasks (Worksheet 14)

Assessment/Audit Tasks: Not applicable.
Data Review Tasks: Data verification is described in Worksheets 34, 35, and 36.

QAPP Worksheet 15 – Reference Limits and Evaluation Tables
Matrix: Sediment
Analytical Group: Bulk Sediment Parameters
Concentration Level: Low

Analyte	CAS Number	Project Action Limits[1]	Project Quantitation Limit[2]	Analytical Method		Achievable Laboratory Limit	
				MDL	Method QL	MDL	QL
Bulk Density	NA	NA	0.001 g	Per ASTM 2216-05	Per ASTM 2216-05	0.001 g (for samples weighing 10-50 grams)	0.001 g
Water Content	NA	NA	0.001 g	Per ASTM 2216-05	Per ASTM 2216-05	0.001 g (for samples weighing 10-50 grams)	0.001 g
Particle Size Distribution	NA	NA	0.04 µm	Per SEI SOP for Grain Size Measurement	Per SEI SOP for Grain Size Measurement	0.04 µm (upper detection limit of 2,000 µm)	0.04 µm
Loss on Ignition	NA	NA	0.1 %	Per ASTM D2974 Version C	Per ASTM D2974 Version C	0.1 %	0.1 %
Erosion Rate	NA	NA	$\Delta z > 0.5$ mm T > 15 seconds	Per SEI Laboratory SOP	Per SEI SOP for SEDflume Testing	$\Delta z > 0.5$ mm T > 15 seconds	$\Delta z > 0.5$ mm T > 15 seconds

NA = Not applicable

1. Project Action Limits are not applicable to bulk sediment parameters.
2. The Project Quantitation Limit is equal to the laboratory achievable QL.

QAPP Worksheet 16
Project Schedule Timeline Table

Project Schedule Timeline Table (Worksheet 16)

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Submit draft QAPP to partner agencies and stakeholders for review	USEPA	09/14/12	09/14/12	Draft QAPP	09/14/12
Receive comments from partner agencies and stakeholders	Draft QAPP reviewers	10/01/12	10/01/12	Technical comments	10/01/12
Prepare and submit final QAPP to USEPA for approval	LBG, HDR|HQI, and SEI	10/01/12	10/08/12	Final QAPP	10/08/12
On-site sediment coring/sampling and SEDflume field work	SEI	10/15/2012	10/31/12	Sediment samples, core logs, and field notes	Refer to draft report
SEI laboratory analyses and consolidation core testing	SEI	11/01/2012	11/30/2012	Analytical data and core logs	Refer to draft report
Draft report preparation and submittal	SEI (SEI and LBG Site Quality Control Officer will coordinate data verication)	12/01/2012	01/18/2013	Draft Newark Bay Erosion Rates Testing Report	01/18/2013
Release of draft report to partner agencies and stakeholders for review	USEPA	TBD	TBD	Draft Newark Bay Erosion Rates Testing Report	TBD
Receive comments from partner agencies and stakeholders	Draft report reviewers	TBD	TBD	Technical comments	TBD
Final report preparation and submittal	SEI	TBD	TBD	Final Newark Bay Erosion Rates Testing Report	TBD

QAPP Worksheet 17

Sampling Design and Rationale

USEPA is implementing a sediment sampling and erosion measurement project to evaluate variability of sediment erosion properties in Newark Bay using replicate samples at several locations. Understanding the variability of Newark Bay sediment erosion properties will provide a basis for characterizing the sediment bed in future hydrodynamic and sediment dynamics modeling efforts. The USEPA field program will consist of:

- In-field SEDFlume testing of 24 cores (12 locations x 2 proximal cores from each location = 24 cores) collected from Newark Bay to evaluate the (*in-situ*) downcore erosion properties of bay sediments. *Data Quality Objective: Analyzing pairs of proximal cores will assess whether small-scale erosion rate variation exists between cores and will yield information on possible bay-wide sediment erosion rate variation. These data will provide initial guidance on (1) developing a sediment transport model from a spatial separation standpoint (i.e., should sediment erosion rate data from one side of Newark Bay be extrapolated and used in other areas of the bay), (2) characterizing variability in downcore erosion rates among proximal cores, and (3) determining if this downcore variability is common to all or select sediment cores that were collected and examined.*
- Laboratory SEDFlume testing of 25 consolidated slurry cores (5 locations × 5 slurry cores = 25 cores plus quality control samples) prepared using surface sediment, consisting of the top 15-30 cm of material (collected via grab sampling) in Newark Bay. Consolidation periods will include 1, 4, 7, 14, and 28 days (generating 5 consolidated slurry cores per sampling location). *Data Quality Objective: Sediment transport modeling requires information on the behavior of sediments during consolidation to accurately describe changes in erosion behavior with time as consolidation occurs. The erosion rates measured from intact field cores are often insufficient to constrain the model representation of consolidation processes.*

Sediment Coring Collection: Sediment cores collected in water depths that are less than 20-25 feet will be obtained using standard push-coring methods. Sediment cores collected in water depths deeper than 20-25 feet will be obtained using a pneumatic/hydraulic coring apparatus that is deployed off a vessel A-Frame. Regardless of the coring technique used, at each sampling location the coring vessel will be anchored such that two cores (and the slurry material grab samples, if applicable) can be collected from coring locations no more than 25 feet apart. Core will be collected in a 10 cm x 15 cm rectangular (in cross-section) core barrel that is up to 60 cm in length; the targeted length of each recovered core is 50-60 cm.

Sediment Grab Sample Collection: Surface sediment will consist of the top 15-30 cm of material. Surface sediment will be collected with a ponar dredge.

Sample Processing: Sediment cores and surface sediment grab samples will be collected and packaged securely. Refer to Worksheets 26 and 27 for details on sample management and sample handling. SEDFlume studies using field-collected sediment cores will be performed by SEI at a nearby, off-site facility (80 Lister Avenue, Newark, NJ). SEDFlume studies using laboratory-consolidated slurry cores will be performed by SEI at their in-house Santa Cruz laboratory.

SEDFlume Studies: SEDFlume sediment cores will be processed following SEI's SOP for SEDFlume Testing (provided in Attachment 1). The SEDFlume studies will be conducted in a structured approach to provide a higher degree of confidence in the erosion rate measurements or finer resolution in depth data. The general SEDFlume approach is provided below:

- Flow rates will be applied across the sediment interface for at least 10 minutes. At the end of a 10 minute interval, the flow rate will be increased. Each flow rate increase will result in an approximate doubling of the applied grain shear stress. If sediment erosion actively occurs within a 10 minute interval, no more than 2 cm of vertical erosion will be allowed. Note that a maximum flow rate can be specified to limit the erosion analysis to the maximum expected applied shear stresses.
- If 2 cm of erosion occurs in less than 3 minutes, the flow rate will not be increased. The shear cycle will be halted and sediments sampled for bulk properties.
- If varying sediment texture is encountered within the cores, the study will be halted and sediments sampled for bulk properties. A new shear cycle will then be restarted at a lower applied grain shear stress.

The following procedure is used to measure erosion rates at several different shear stresses using only one core. Starting at a low shear stress, the flume is run sequentially at higher shear stresses, with each succeeding shear stress being twice the previous one. Generally at least three shear stresses are run sequentially, if feasible. Each shear stress is applied

until at least 1 to 3 mm but no more than 2 cm are eroded. The time interval is recorded for each run with a stopwatch. The flow rate is subsequently increased (*i.e.*, increasing the applied shear stress) until at least 3 measureable erosion rates are obtained (if feasible). This cycle is repeated until all of the sediment has eroded from the core. If after three cycles a particular shear stress shows a rate of erosion less than 10^{-4} cm/s (which is the project-specific critical shear stress), it will be dropped from the cycle; if after many cycles the erosion rates decrease significantly, a higher shear stress will be included in the cycle.

Sampling Method:

Field SOPs are provided in Attachment 1

- SEI SOP for SEDflume Testing

Selected laboratory SOPs are provided in Attachment 2

- Bulk density: ASTM 2216-05
- Water content: ASTM 2216-05
- Particle size: SEI SOP for Grain Size Measurement
- LOI: ASTM D2974 Version C

QAPP Worksheet 18
Sampling Locations and Methods/SOP Requirements Table

Sampling Locations and Methods/SOP Requirements Table (Worksheet 18)

Sampling Location/ID Number	Matrix	Depth	Analytical Group	Conc Level	Estimated Number of Samples (identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
SF-1 SF-1C	In-field sediment core and co-located surface sediment for laboratory consolidation slurry cores	Cores: 60 cm Sediment: 0 to 15-30 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores 1 surface sediment composite sample	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Potentially higher contribution of Passaic and Hackensack River sediments. Contrast with Station 2 for indication of variability from shallow vs. deeper water depth. Locally higher shear stresses and potentially affected by ship traffic.
SF-2	In-field sediment core	Cores: 60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Likely higher contribution of Passaic and Hackensack River sediments. Station 1 will provide indication of variability from shallow vs. deeper water depth.
SF-3	In-field sediment core	Cores: 60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Stations 4 and 5 for lateral variability.
SF-4 SF-4C	In-field sediment core and co-located surface sediment for laboratory consolidation slurry cores	60 cm Sediment: 0 to 15-30 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores 1 surface sediment composite sample	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Contrast with Stations 3 and 5 for lateral variability. Locally higher shear stresses and potentially affected by ship traffic.
SF-5 SF-5C	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Stations 3 and 4 for lateral variability. Evaluate downcore erosion rates and assess whether small-scale erosion rate variation exists between proximal cores.
SF-6 SF-6C	In-field sediment core and co-located surface sediment for laboratory consolidation slurry cores	Cores: 60 cm Sediment: 0 to 15-30 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores 1 surface sediment composite sample	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Contrast with Station 7 for lateral variability. Locally higher shear stresses and potentially affected by ship traffic.

Sampling Locations and Methods/SOP Requirements Table (Worksheet 18)

Sampling Location/ID Number	Matrix	Depth	Analytical Group	Conc Level	Estimated Number of Samples (identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
SF-7	In-field sediment core	Cores: 60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Station 6 for lateral variability.
SF-8	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Stations 9 and 10 for lateral variability. Potentially higher contribution of Kill Van Kull solids.
SF-9	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Contrast with Stations 8 and 10 for lateral variability. Locally higher shear stresses and potentially affected by ship traffic. Potentially higher contribution of Kill Van Kull solids.
SF-10	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Stations 8 and 9 for lateral variability. Potentially higher contribution of Kill Van Kull solids.
SF-11 SF-11C	In-field Sediment Core and co-located surface sediment for laboratory consolidation slurry cores	60 cm Sediment: 0 to 15-30 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores 1 surface sediment composite sample	Refer to Worksheet 21	Station located in sub-tidal area. Contrast with Station 12 for indication of variability from shallow vs. deeper water depth.
SF-12	In-field Sediment Core	60 cm	Bulk density Water content Particle size LOI Erosion Rate	Low	2 replicate sediment cores	Refer to Worksheet 21	Station located at toe of channel slope (subject to verification). Contrast with Station 12 for indication of variability from shallow vs. deeper water depth.

1: Refer to Figure 2 for proposed sampling locations within the Newark Bay Study Area.
2: Exact coordinates of sampling locations will be determined prior to the field effort.
3: Refer to Worksheet 20 for number of field samples; field crew will randomly select one sampling location from the following locations SF-1C, SF-4C, SF-5C, SF-6C, or SF-11C to obtain quality control samples for the laboratory consolidated slurry cores.

QAPP Worksheet 19
Analytical SOP Requirement Table

Analytical SOP Requirements Table (Worksheet 19)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Sediment Cores	Bulk density Water content Particle size LOI Erosion Rate	Low	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SEI SOP for Gain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SEI SOP for SEDflume Testing	9,000 cm^3 per sediment core	Two Core Barrel (10 cm × 15 cm × 60 cm)	No preservation. Cores must be maintained in vertical position to preserve the integrity of the surface sediment and transport/handling must be minimized prior to SEDflume testing.	28 days
Surface Sediment (Grab)	Bulk density Water content Particle size LOI Erosion Rate	Low	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SEI SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SEI SOP for SEDflume Testing	15 gallons	Three 5-gallon buckets with lids	No preservation.	28 days

QAPP Worksheet 20
Field Quality Control Sample Summary Table

Field Quality Control Sample Summary Table (Worksheet 20)

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference	Number of Coring Locations	Number of Field Duplicates	Number of Replicates	Total Number of Samples
Sediment Cores	Bulk density Water content Particle size LOI Erosion Rate	Low	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SEI SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SEI SOP for SEDflume Testing	12	0	2 replicate cores per location	24 sediment cores
Surface Sediment (Grab)	Bulk density Water content Particle size LOI Erosion Rate	Low	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SEI SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SEI SOP for SEDflume Testing	5	1	0	6 surface sediment samples (sample mass will generate 30 consolidated slurry cores in the laboratory; 5 slurry cores per sampling locations plus field duplicate)

QAPP Worksheet 21
Project Sampling SOP Reference Table

Project Sampling SOP References Table (Worksheet 21)

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work?	Comments
SOP No. 1	SEI Standard Operating Procedure for SEDFlume Testing	SEI	SEDFlume	Yes	Attachment 1

QAPP Worksheet 22
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment Calibration, Maintenance, Testing, and Inspection Table (Worksheet 22)

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
SEDFlume	Flow	SEDFlume flow meter will be checked daily by directly measuring the volume of water collected over time at the outlet of the channel.	Refer to maintenance activity	Refer to maintenance activity	Daily and before each use	Measured flow rates ±20% of recorded flows	If the flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this inspection does not correct the problem, a new flow meter will be installed.	SEI	SEI Laboratory SOP for SEDFlume Testing, September 2012, Revision 1.0
SEDFlume	Jack Movement	Jack movement will be checked daily by directly measuring core movement in the SEDFlume.	Refer to maintenance activity	Refer to maintenance activity	Daily and before each use	Minimum jack movement of 0.5 mm	If jack movement is not correct, jack will be inspected. If this inspection does not correct the problem, a new jack will be installed.	SEI	SEI Laboratory SOP for SEDFlume Testing, September 2012, Revision 1.0

QAPP Worksheet 23
Analytical SOP Reference Table

Analytical SOP References Table (Worksheet 23)

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
Bulk Density	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	Definitive	Bulk Density	Gravimetric	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	No
Water Content	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)	Definitive	Water Content	Gravimetric	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	No
Particle Size	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2	Definitive	Particle Size	Laser Diffraction	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	No
LOI	ASTM D2974 Version C "Standard Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"	Definitive	LOI	Loss on Ignition	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	Yes, refer to Note 1
Erosion Rates	SEI Laboratory SOP for SEDflume Testing, September 2012, Revision 1.0	Definitive	Erosion Rates	SEDFlume	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	No

1: For this study, LOI will be handled as a physical parameter to provide bulk sediment characteristics. Consequently, sediment samples for LOI analysis will not be preserved and LOI values will only be verified (not validated).

QAPP Worksheet 24
Analytical Instrument Calibration Table

Analytical Instrument Calibration Table (Worksheet 24)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
Gravimetric (Bulk Density and Water Content)	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS and balance tare	Daily	Balance verification ±0.0003 grams of certified standard. Balance Tare = Zero ±0.0003 grams	Inspect and recalibrate as necessary; refer to manufacturer's manual	SEI (Jason Magalen or designee)	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)
Laser Diffraction (Particle Size)	As stipulated by manufacturer with 35 micron particle standard	Hourly	As stipulated by manufacturer	Inspect and recalibrate as necessary; refer to manufacturer's manual	SEI (Jason Magalen or designee)	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2
Loss on Ignition (LOI)	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS and balance tare	Daily	Balance verification ±0.0003 grams of certified standard. Balance Tare = Zero ±0.0003 grams	Inspect and recalibrate as necessary; refer to manufacturer's manual	SEI (Jason Magalen or designee)	ASTM D2974 Version C "Standard Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"
SEDFlume (Erosion)	Refer to Worksheet 22	Refer to Worksheet 22	Refer to Worksheet 22	Refer to Worksheet 22	Refer to Worksheet 22	Refer to Worksheet 22

QAPP Worksheet 25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
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Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (Worksheet 25)

Instrument/ Equipment [1,2]	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Refer to list of instruments provided in Worksheet 24 [1,2]	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24	Refer to Worksheet 24

1. The maintenance of the analytical instruments including the testing activity, inspection activity, frequency, acceptance criteria, responsible person, and SOP reference must be documented in the Laboratory Quality Manual.
2. Spare parts and maintenance of laboratory analytical instrumentation is the responsibility of the assigned laboratory.

QAPP Worksheet 26
Sample Handling System

Sample Handling System (Worksheet 26)
SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Managed by SEI
Sample Packaging (Personnel/Organization): Managed by SEI
Coordination of Shipment (Personnel/Organization): Managed by SEI
Type of Shipment/Carrier: Federal Express for overnight delivery or courier to the laboratory
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Managed by SEI
Sample Custody and Storage (Personnel/Organization): Managed by SEI
Sample Preparation (Personnel/Organization): Managed by SEI
Sample Determinative Analysis (Personnel/Organization): Managed by SEI
SAMPLE ARCHIVING
Field Sample Storage (Number of days from sample collection): Field samples do not require preservation. Sample holding time is 28 days.
Sample Extract/Digestate Storage (Number of days from extraction/digestion): Not applicable. Field samples do not require preservation.
SAMPLE DISPOSAL
Personnel/Organization: SEI and LBG
Number of Days from Analysis: At least 3 months

Sample Handling and Custody

Sample custody procedures ensure the timely, correct, and complete analysis of each sample for all parameters requested. A sample is considered to be in someone's custody if it:

- Is in his/her possession.
- Is in his/her view, after being in his/her possession.
- Is in his/her possession and has been placed in a secured location.
- Is in a designated secure area.

Sample custody documentation provides a written record of sample collection and analysis. The sample custody procedures provide for specific identification of samples associated with an exact location and the recording of pertinent information associated with the sample, including time of sample collection and any preservation techniques. For the erosion rate testing effort, field data sheets and core logs will serve as physical evidence of sample custody, since sediment cores and grab samples will remain in SEI custody from collection to analysis.

Field Sample Handling and Custody

Field records such as core logs and field data sheets provide a means of recording information for each field activity performed at the Site and documenting sample handling and custody. Worksheet 19 lists the specific sample preservation requirements for each test method.

Field Procedures

The general responsibilities of the field team are listed below:

- The SEI field crew is personally responsible for the care and custody of the samples until they are properly dispatched. As few people as possible should handle the samples.
- The field crew is responsible for entering the proper information on the core logs and field data sheets, including all pertinent information such as sample identification number, date and time of sample collection, type of analysis, and description of sample location, while conducting the field activities.
- All samples will be labeled with the project identification, sample number, matrix, type of analysis required, and preservation requirements techniques employed, if applicable.
- The samples will be properly preserved, bagged, and packed.
- The SEDflume Task Leader will review all field activities to determine whether proper custody procedures were followed during the field work and if additional samples are required.

Field Records

The core logs and field data sheets will provide the means of recording data collection activities and field observations. Entries will be described in as much detail as possible so that persons going to the Site can reconstruct a particular situation without reliance on memory. At the beginning of each day, the date, start time, weather, and names of all sampling team members present will be entered. The names of visitors to the Site and the purpose of their visit will also be recorded. All field measurements, as well as the instrument(s), will be noted. Sample identification numbers will be assigned at the time the data are entered in the field notebook.

Sample Identification System

All samples collected from the Site must be identified with a sample label in addition to an entry on the core logs. Indelible ink will be used to complete sample labels and handwritten field records. Refer to Worksheet 27 on Sample Identification.

Sample Labels/Tags

The field team is required to complete the following information on a sample label for each sample container:

1. Site Name
2. Unique Sample Number
3. Sample Matrix
4. Parameters to be analyzed
5. Date of Collection
6. Time of Collection
7. Preservation Technique Employed (if applicable)
8. Sampler's Name

Sample Receipt

A designated sample custodian at SEI will accept custody of the samples and verify that the information on the sample labels matches the information on the core logs and field data sheets. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory. Once the samples have been accepted by the SEI laboratory, checked and logged in, they must be maintained in accordance with laboratory custody and security requirements. Laboratory personnel are responsible for the custody of samples until they are returned to the sample custodian.

When sample analyses and quality assurance checks have been completed in the laboratory, the used portion of the sample must be stored or disposed of in accordance with the protocols specified in the laboratory SOW or the subcontract agreement. Identifying labels, data sheets, core logs, and laboratory records will be retained for the recordkeeping duration specified in the USACE contract and task order.

QAPP Worksheet 27
Sample Custody Requirements

Sample Custody Requirements (Worksheet 27)
Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Sample collection: Refer to Worksheet 17 on sample design rationale; refer to Field SOPs provided in Attachment 2 Packaging: Refer to Worksheet 19 for sample container and preservation Shipment and delivery to laboratory: SEI will be responsible for delivering sediment cores to the off-site processing facility (location to be determined) and shipping surface sediment samples to the SEI Santa Cruz laboratory.
Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): SEI laboratory will have a sample custodian, who accepts custody of the samples and verifies that the information on the sample labels matches the information on the core logs and field data sheets. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory.
Sample Identification Procedures: In the field, sediment cores and surface sediment samples will be logged using the location identification numbers noted on Worksheet 18. Unique sample identification numbers will be provided by SEI during the SEDFlume study. For example, SF1C-1 will denote consolidated slurry core collected at location "1C" after 1 day of consolidation.

Chain of Custody Procedure

Field records (core logs and field data sheets) prepared by SEI will serve as documentation of the collection and custody of the sediment cores, grab samples, and bulk property samples, since sample collection and analysis will remain completely internal to SEI.

Shipment

Grab samples to be used to prepare consolidation cores will be shipped from Newark, NJ to the SEI laboratory in Santa Cruz, CA. If the samples are sent by common carrier or air freight, proper documentation must be maintained. For example, the bill of lading or airbill must be retained by the SEDflume Task Leader.

Laboratory Custody Procedures

The laboratory custody procedures will include the following procedures:

- A designated sample custodian will accept custody of the samples and verify that the information on the sample labels matches the information on the core logs and field data sheets. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt at the laboratory.
- Once the samples have been accepted by the laboratory, checked and logged in, they must be maintained in accordance with laboratory custody and security requirements.
- Laboratory personnel are responsible for the custody of samples until they are returned to the sample custodian.
- When sample analyses and quality assurance checks have been completed in the laboratory, the used portion of the sample must be stored or disposed of in accordance with the protocols specified in the laboratory SOP or the subcontract agreement. Identifying labels, data sheets, COCs, and laboratory records will be retained for the recordkeeping duration specified in the USACE contract and task order.

Final Evidence Files

Core logs, field data sheets, sample preparation and analysis logbooks, and data packages will become part of the laboratory final evidence file. Other relevant documentation including records, reports, and correspondence, logs, pictures, and data review reports will be archived by SEI.

Sample Holding Times

Information on sample holding times and required preservation for each test method are provided in Worksheet 19.

Sample Packaging and Shipping Requirements

Custody of samples will be documented by SEI through the shipment of samples to their laboratory in Santa Cruz, CA by retaining airbills or bills of lading, for example, and by verifying sample label information upon receipt at their laboratory.

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Bulk Density		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)		**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Detection limit	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	SEI (Jason Magalen or designee)	Sensitivity	MDL defined per SEI Laboratory SOP
Balance Tare	Daily before use	ASTM 2216-05 (SEI Laboratory SOP)	Re-tare balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Sensitivity	Zero ±0.0003 grams
Laboratory Control Sample	Daily before use	ASTM 2216-05 (SEI Laboratory SOP)	Re-calibrate balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard
Constant Dry Mass	Per sample	ASTM 2216-05 (SEI Laboratory SOP)	Continue drying sample until <1% loss in mass with drying at 110±5 degrees Celsius	SEI (Jason Magalen or designee)	Accuracy	<1% loss in mass with drying at 110±5 degrees Celsius for minimum of 12 hours

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Bulk Density		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)		**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Laboratory replicate	Per sample	ASTM 2216-05 (SEI Laboratory SOP)	Notify SEDflume Task Leader; assess results from three analytical runs and determine whether additional runs are warranted to minimize RPD	SEI (Jason Magalen or designee)	Precision	RPD $\leq$ 20% for the three analytical runs; results represent the average
Field duplicate	1 per sampling event	ASTM 2216-05 (SEI Laboratory SOP)	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD $\leq$ 40% for consolidated slurry cores
Data quality assessment	Per sediment core	Field SOP SEDFlume	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	$\geq$ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Water Content		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)		**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Detection limit	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	SEI (Jason Magalen or designee)	Sensitivity	MDL defined per SEI Laboratory SOP
Balance Tare	Daily before use	ASTM 2216-05 (SEI Laboratory SOP)	Re-tare balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Sensitivity	Zero ±0.0003 grams
Laboratory Control Sample	Daily before use	ASTM 2216-05 (SEI Laboratory SOP)	Re-calibrate balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard
Constant Dry Mass	Per sample	ASTM 2216-05 (SEI Laboratory SOP)	Continue drying sample until <1% loss in mass with drying at 110±5 degrees Celsius	SEI (Jason Magalen or designee)	Accuracy	<1% loss in mass with drying at 110±5 degrees Celsius for minimum of 12 hours

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Water Content		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference	ASTM 2216-05 (SEI Laboratory SOP "Procedure for Measurement of Water Content" January 13, 2009, Revision 1.3)		**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Laboratory replicate	Per sample	ASTM 2216-05 (SEI Laboratory SOP)	Notify SEDflume Task Leader; assess results from three analytical runs and determine whether additional runs are warranted to minimize RPD	SEI (Jason Magalen or designee)	Precision	RPD ≤ 20% for the three analytical runs; results represent the average
Field duplicate	1 per sampling event	ASTM 2216-05 (SEI Laboratory SOP)	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 40% for consolidated slurry cores
Data quality assessment	Per sediment core	Field SOP SEDFlume	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Particle Size		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2		**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Detection limit	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	As defined in SEI laboratory SOP	SEI (Jason Magalen or designee)	Sensitivity	MDL defined per SEI Laboratory SOP (99% confidence level)
Method blank	Per sample	SEI laboratory SOP	Repeat instrument flush with tap water; if problem continues, notify SEDflume Task Leader and consult instrument manual	SEI (Jason Magalen or designee)	Sensitivity	≤ QL (flush instrument with clean tap water)
Laboratory Control Sample (35 micron particle)	Every hour	SEI laboratory SOP	Repeat analysis of LCS; if problem continues, notify SEDflume Task Leader and consult instrument manual. Reanalyze impacted field samples.	SEI (Jason Magalen or designee)	Accuracy	As stipulated by manufacturer
Laboratory replicate	Per sample	SEI Laboratory SOP	Notify SEDflume Task Leader; assess results from three analytical runs and determine whether additional runs are warranted to minimize RPD	SEI (Jason Magalen or designee)	Precision	RPD ≤ 1% for the three analytical runs; results represent the average
Field duplicate	1 per sampling event	SEI Laboratory SOP	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 50% for consolidated slurry cores

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Particle Size		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference	SEI Laboratory SOP "Sedflume Sediment Grain Size Analysis" July 6, 2008, Revision 1.2		**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Data quality assessment	Per sediment core	Field SOP SEDFlume	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	LOI		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference			**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Detection limit	As defined in ASTM D2974 Version C	As defined in ASTM D2974 Version C	As defined in SEI laboratory SOP	SEI (Jason Magalen or designee)	Sensitivity	MDL defined per ASTM D2974 Version C
Balance Tare	Daily before use	As defined in ASTM D2974 Version C	Re-tare balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Sensitivity	Zero ±0.0003 grams (checked daily)
Laboratory Control Sample	Daily before use	As defined in ASTM D2974 Version C	Re-calibrate balance; refer to instrument manufacturer's manual if problems continue and notify SEDflume Task Leader. Field samples will not be analyzed until balance is calibrated and tared.	SEI (Jason Magalen or designee)	Accuracy	As stipulated by manufacturer; balance verification conducted on 1 gram LCS and 50 gram LCS; balance ±0.0003 grams of certified standard (checked daily)
Constant Dry Mass	Per sample	As defined in ASTM D2974 Version C	Continue drying sample until <1% loss in mass with drying at 110±5 degrees Celsius	SEI (Jason Magalen or designee)	Accuracy	<1% loss in mass with drying at 440±22 degrees Celsius for minimum of 1 hour

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	LOI		**Sampler's Name**		Field crew	
Concentration Level	Low		**Field Sampling Organization**		SEI	
Sampling SOP	Refer to Worksheet 21		**Analytical Organization**		SEI	
Analytical Method/ SOP Reference			**No. of Sample Locations**		Refer to Worksheet 18	
QC Sample	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Laboratory replicate	Per sample	As defined in ASTM D2974 Version C	Notify SEDflume Task Leader; assess results from three analytical runs and determine whether additional runs are warranted to minimize RPD	SEI (Jason Magalen or designee)	Precision	RPD ≤ 20% for the three analytical runs; results represent the average
Field duplicate	1 per sampling event	As defined in ASTM D2974 Version C	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 40% for consolidated slurry cores
Data quality assessment	Per sediment core	As defined in ASTM D2974 Version C	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 28

QC Samples Table for Suspended Solids (Worksheet 28)

Analyte/Matrix	Erosion Rates	**Sampler's Name**	Field crew
Concentration Level	Low	**Field Sampling Organization**	SEI
Sampling SOP	Refer to Worksheet 21	**Analytical Organization**	SEI
Analytical Method/ SOP Reference	SEI Laboratory SOP "SEDFlume" September 2012, Revision 1.0	**No. of Sample Locations**	Refer to Worksheet 18

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Flow rates	Daily before use	SEI laboratory SOP; Refer to Worksheet 22	If the flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this inspection does not correct the problem, a new flow meter will be installed. Refer to Worksheet 22.	SEI (Jason Magalen or designee)	Accuracy/Sensitivity	Flow meter checked daily; measured flow rates ±20% of recorded flows
Jack movement	Daily before use	SEI laboratory SOP; Refer to Worksheet 22	If jack movement is not correct, jack will be inspected. If this inspection does not correct the problem, a new jack will be installed.	SEI (Jason Magalen or designee)	Accuracy/Sensitivity	Jack movement ≥ 0.5 mm
Critical shear stress	Per sample	SEI laboratory SOP	Notify SEDflume Task Leader and assess data impacts	SEI (Jason Magalen or designee)	Accuracy	10^{-4} cm/s (which represents 1 mm of erosion in approximately 15 minutes)
Field duplicate	1 per sampling event	SEI Laboratory SOP	Notify SEDflume Task Leader; assess impacts to consolidated slurry sediment cores; repeat analysis as required	SEI (Jason Magalen or designee)	Precision	RPD ≤ 50% for consolidated slurry cores
Data quality assessment	Per sediment core	Field SOP SEDFlume	Assess field conditions and re-collect sediment core	SEI (Jason Magalen or designee)	Recovery	≥ 80% core recovery (48-60 cm) for in-field sediment cores

QAPP Worksheet 29
Project Documents and Records Table

Project Documents and Records Table (Worksheet 29)

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Field notes and photographs	Field notes and photographs	Electronic copies of field notes will be made and stored in the project files	Not applicable	None
Shipping records	Air bills (or bills of lading)	Electronic copies of air bills will be kept in project files	Project Records	None
Analytical and sample data packages	Core logs and field data sheets	Instrument calibration records and laboratory data will be stored in electronic or hardcopy format.	Laboratory quality assurance checklist	None
Data verification reports for laboratory data	Core logs and field data sheets	Submitted to the USEPA and stored in project electronic files directory	Quality assurance checklists	None
Final Report	Not applicable	Submitted to the USEPA and stored in project electronic file directory	Quality assurance checklists	None

Project Document Control System

Project documents will be controlled by LBG Project Manager, who will maintain and distribute hardcopies and electronic copies of the project documents and any amendments. Electronic copies of project information will be maintained in the project electronic file directory and the project database.

Data Recording

Data for this project will be collected by entries onto core logs and field data sheets. Electronic copies of these records will be created and saved in the project directory. Computer-generated data associated with laboratory analyses will be generated by the SEI laboratory.

Data Quality Assurance Checks

The SEDflume Task Leader will monitor the progress of sample collection to verify that samples are collected as planned. The progress of sample collection and processing will be monitored through documentation of the samples collected each day. The laboratory will have a formal in-house Quality Assurance Plan to which it adheres and implements as part of daily operations. Data generation processes will be reviewed and modified to meet objectives, if necessary. A formalized data generation procedure will be utilized. Each analyst must have previously demonstrated, through the laboratory quality assurance program, their requisite skills.

Laboratory Data Transmittal

Laboratory data are managed by the laboratory's internal management system, beginning with sample check-in. Laboratory data reports will be provided as an attachment to the Newark Bay Erosion Rate Testing report.

Data Storage and Retrieval

Electronic copies of field notes, photographs, core logs and field data sheets will be saved and archived in the project directory. The full laboratory data reports submitted to LBG will be stored in the custody of the Site Quality Control Officer. Raw data and electronic media of all field samples, including quality control samples and blanks, will be archived from the date of generation and will be kept by the laboratory. Hard copies of project files will be archived at SEI offices and retained until the end of the contract; project closeout will be conducted in accordance with USEPA Close-out Guidelines. Data will be transferred to the USACE and USEPA upon completion of the project. Retrieval of data by others will be at the discretion of the USACE and the USEPA. The length of time that records will be archived will be at the discretion of the USACE and USEPA.

QAPP Worksheet 30
Analytical Services Table

Analytical Services Table

Matrix	Analytical Group	Conc Level	Sample Location/ ID Numbers	Analytical SOP [1]	Data Package Turnaround Time[2]	Laboratory (Name and Address, Contact Person, and Telephone Number)	Backup Laboratory/
In-field Sediment Cores	Bulk density Water content Particle size LOI Erosion Rate	Low	Refer to Worksheet 18	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SOP for SEDflume Testing	60 days (analytical) 30 days (verification)	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	A back-up laboratory has not been assigned at this time.
Surface Sediment (Grab)	Bulk density Water content Particle size LOI Erosion Rate	Low	Refer to Worksheet 18	Bulk density: ASTM 2216-05 Water content: ASTM 2216-05 Particle size: Per SOP for Grain Size Measurement LOI: ASTM D2974C Erosion Rate: Per SOP for SEDflume Testing	60 days (analytical) 30 days (verification)	Sea Engineering, Inc. 200 Washington Street, Suite 210 Santa Cruz, CA 95060 Tel: (541) 740-3715	A back-up laboratory has not been assigned at this time.

QAPP Worksheet 31
Planned Project Assessments Table

Planned Project Assessments Table (Worksheet 31)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Quality control reports of any non-conformance	Daily as required	Internal	SEI	Field Crew	SEDflume Task Leader (LBG Project Manager will be notified)	SEDflume Task Leader	SEDflume Task Leader
Field Health and Safety Audit	Within the first two weeks of work	Internal	SEI	SEI Field Leader	SEDflume Task Leader (LBG Project Manager will be notified)	SEDflume Task Leader	SEDflume Task Leader

QAPP Worksheet 32
Assessment Findings and Corrective Action Responses

Assessment Findings and Corrective Action Responses (Worksheet 32)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Non-Conformance	See below	LBG Project Manager and USEPA	As soon as possible	Complete non-conformance form	SEI Field Team Leader and Field Crew	As soon as possible

Non-Conformance/QC Reporting

A non-conformance is defined as an identified or suspected deficiency or discrepancy with regard to an approved document (*e.g.,* improper sampling procedures, improper instrument calibration, calculation, computer program); or an item where the quality of the end product itself or subsequent activities using the document or item would be affected by the deficiency; or an activity that is not conducted in accordance with the established plans or procedures.

Any staff member engaged in project work that discovers or suspects a non-conformance is responsible for initiating a non-conformance report to the SEDflume Task Leader, Site Quality Control Officer or designee. The Site Quality Control Officer will evaluate each non-conformance report, and the Site Quality Control Officer will provide a disposition which describes the actions to be taken.

The Project Manager will verify that no further project work dependent on the nonconforming item or activity is performed until approval is obtained and the non-conformance is properly addressed. If the non-conformance is related to material, the Project Manager shall be responsible for making or identifying, with the non-conformance report number, the nonconforming item (if practical) and indicating that it is nonconforming and is not to be used. A copy of each non-conformance report will be included in the project file. Copies of all non-conformances shall be maintained by the Site Quality Control Officer or designee.

Field Corrective Actions

At the end of each sampling day, the field team is to report any problems requiring corrective action that were encountered during the day. Corrective action will be undertaken when a non-conforming condition is identified. A non-conforming condition occurs when QA objectives for precision, accuracy, completeness, representativeness, or comparability are not met, or when procedural practices or other conditions are not acceptable. A report is to be filed that documents the problems encountered and the corrective action implemented. A Stop-Work Order may be issued by the Site Quality Control Officer or designee, following notification to the Project Manager, if corrective action does not adequately address a problem, or if no resolution can be reached.

Internal Laboratory Audits

As part of its quality assurance program, the Laboratory Quality Assurance Manager will conduct periodic checks and audits of the analytical systems to ensure that the systems are working properly and personnel are adhering to established procedures and documenting the required information. These checks and audits will also assist in determining or detecting where problems are occurring. In addition to conducting internal reviews and audits, as part of its established quality assurance program, the laboratory is required to take part in regularly scheduled performance evaluation and laboratory audits from state and federal agencies for applicable tests. Each laboratory selected to support this program must maintain current state or federal certifications, as appropriate.

Laboratory Corrective Actions

If a particular laboratory analysis is deemed "out of control," corrective action will be taken by the laboratory to maintain continued data quality, with adherence to their corrective action policy. The coordinator of the laboratory's analytical section will be responsible for initiating laboratory corrective action when necessary.

QAPP Worksheet 33
QA Management Reports Table

QA Management Reports Table				
Type of Report	**Frequency (daily, weekly monthly, quarterly, annually, etc.)**	**Projected Delivery Date(s)**	**Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)**	**Report Recipient(s) (Title and Organizational Affiliation)**
Field Health and Safety Audit	Within the first two weeks of field work	Month after field work begins	Health and Safety Manager or designee	USEPA and USACE
Data Verification Report	After laboratory data are received	Within 30 days after receiving data	Site Quality Control Officer or designee	USEPA and USACE
Corrective Action Reports	When corrective action is required	When corrective action is implemented	Project Manager	USEPA and USACE

The USACE and USEPA will receive several types of management reports. These reports will include the results of any corrective action reports and data verification reports. Problems or issues that arise between regular reporting periods may be identified to program management at any time. Information included in these reports will include the following:

- Results of Field Health and Safety Audit conducted during the period.
- An assessment of any problems with the measurement data, including accuracy, precision, completeness, representativeness, and comparability.
- A listing of the non-conformance reports including Stop-Work Orders issued during the period, related corrective actions undertaken, and an assessment of the results of these actions.
- Identification of significant quality assurance problems and recommended solutions, as necessary.

QAPP Worksheet 34
Verification (Step I) Process Table

Verification (Step I) Process Table (Worksheet 34)			
Verification Input	**Description**	**Internal/ External**	**Responsible for Verification (Name, Organization)**
Field Notes	Review the field notes for errors or omissions. This information is transmitted to the SEDflume Task Leader or designee for correction.	Internal	SEI Field Leader
Final Report	Final report will be reviewed; Quality control checklist will be signed and submitted to the USACE and USEPA.	Internal	SEI
Laboratory data packages	Laboratory data reports will be verified by the laboratory for completeness and technical accuracy prior to release.	External	SEI
	Laboratory data will be assessed using the verification procedures described in Worksheets 35 and 36.	External	SEI and LBG Site Quality Control Officer

QAPP Worksheet 35
Validation (Steps IIa and IIb) Process Table

Validation (Steps IIa and IIb) Process Table (Worksheet 35)			
Step IIa/IIb	**Validation Input**	**Description**	**Responsible for Validation**
IIa	Field Notes and photographs	Record field activities and collection of samples. Record implementation of QAPP.	SEI
IIa	Core logs and field data sheets	Examine traceability of data from sample collection to generation of project report.	SEI
IIa	Laboratory data reports	Verify the required deliverables, analyte list, analytical procedures, and project quantitation limits.	SEI
IIa	Data verification reports	Verify that data quality and usability was adequately communicated to the data users.	LBG Site Quality Control Officer
IIb	Laboratory data reports and validation guidance	Data verification according to Worksheets 36 and 37	LBG Site Quality Control Officer
IIb	Deviations from SOP and project documents.	Determine impacts of any deviation from method and the project plan.	Project Team

QAPP Worksheet 36
Validation (Steps IIa and IIb) Summary Table

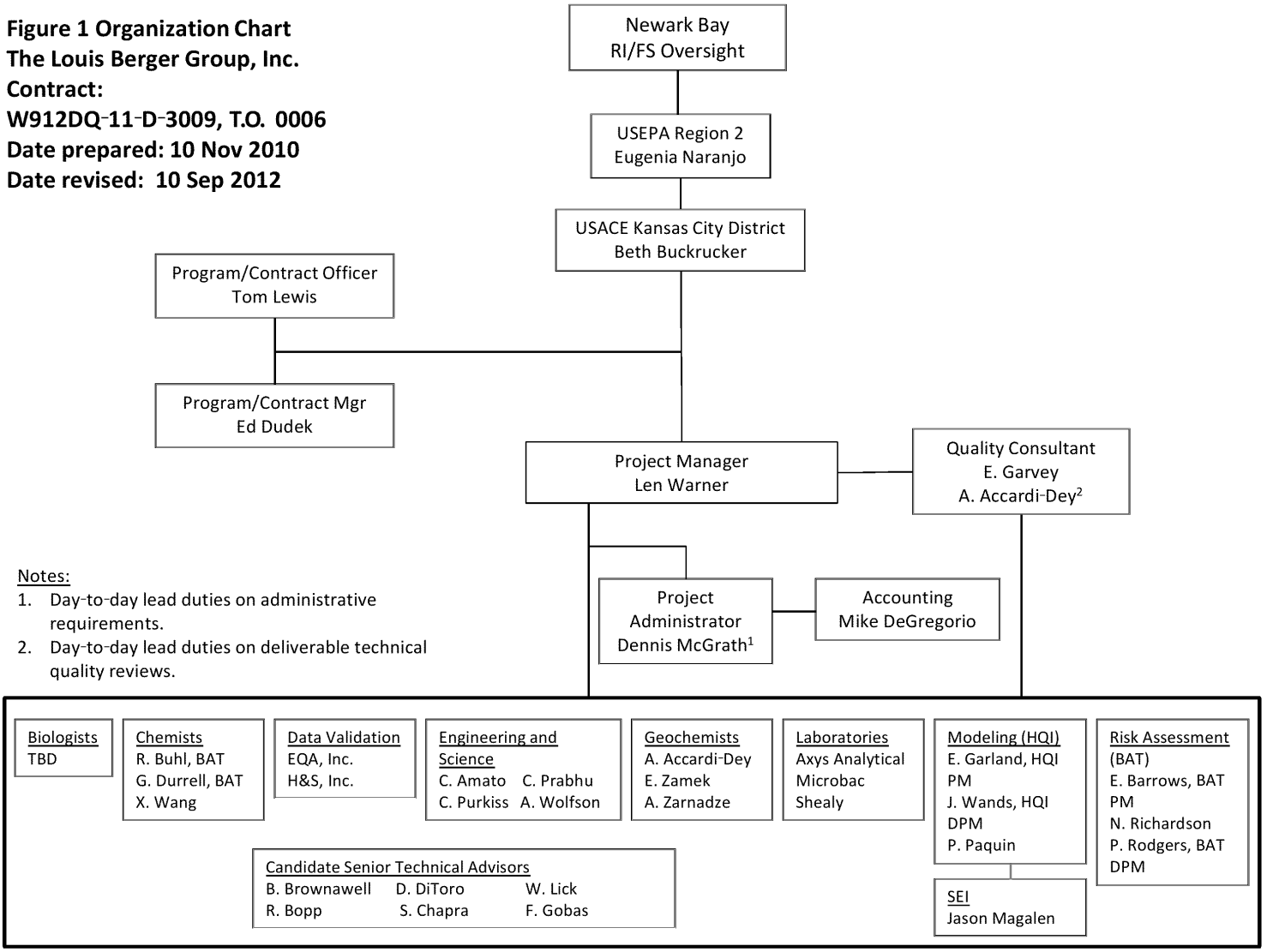
Validation (Steps IIa and IIb) Summary Table					
Step IIa/IIb	**Matrix**	**Analytical Group**	**Concentration Level**	**Validation Criteria**	**Data Validator (title and organizational affiliation)**
IIa/IIb	Sediment	Bulk Sediment Parameters	Low	Verification based on Worksheet 12, 15, 24, 28 in QAPP and method SOPs; independent check on calculation for 25% of the samples	LBG Site Quality Control Officer
IIa/IIb	Sediment	Erosion Rate Calculations	Low	Verification based on Worksheet 12, 15, 24, 28 in QAPP and method SOPs; independent check on calculation for 25% of the samples	LBG Site Quality Control Officer

Subcontractor Laboratory Data
The subcontractor laboratory data will be verified by LBG Site Quality Control Officer against the QAPP and method criteria. The data verifier will also conduct a review of 25% of the samples for each analytical parameter. This means that the data verifier will review the raw data and log book sheets, and will recalculate sample and QC sample results. Once data verification is completed, a data verification report will be generated. The report will contain information regarding the parameters that are qualified, the reason for the qualification, and the direction of the bias (only for parameters qualified as estimated), when possible.

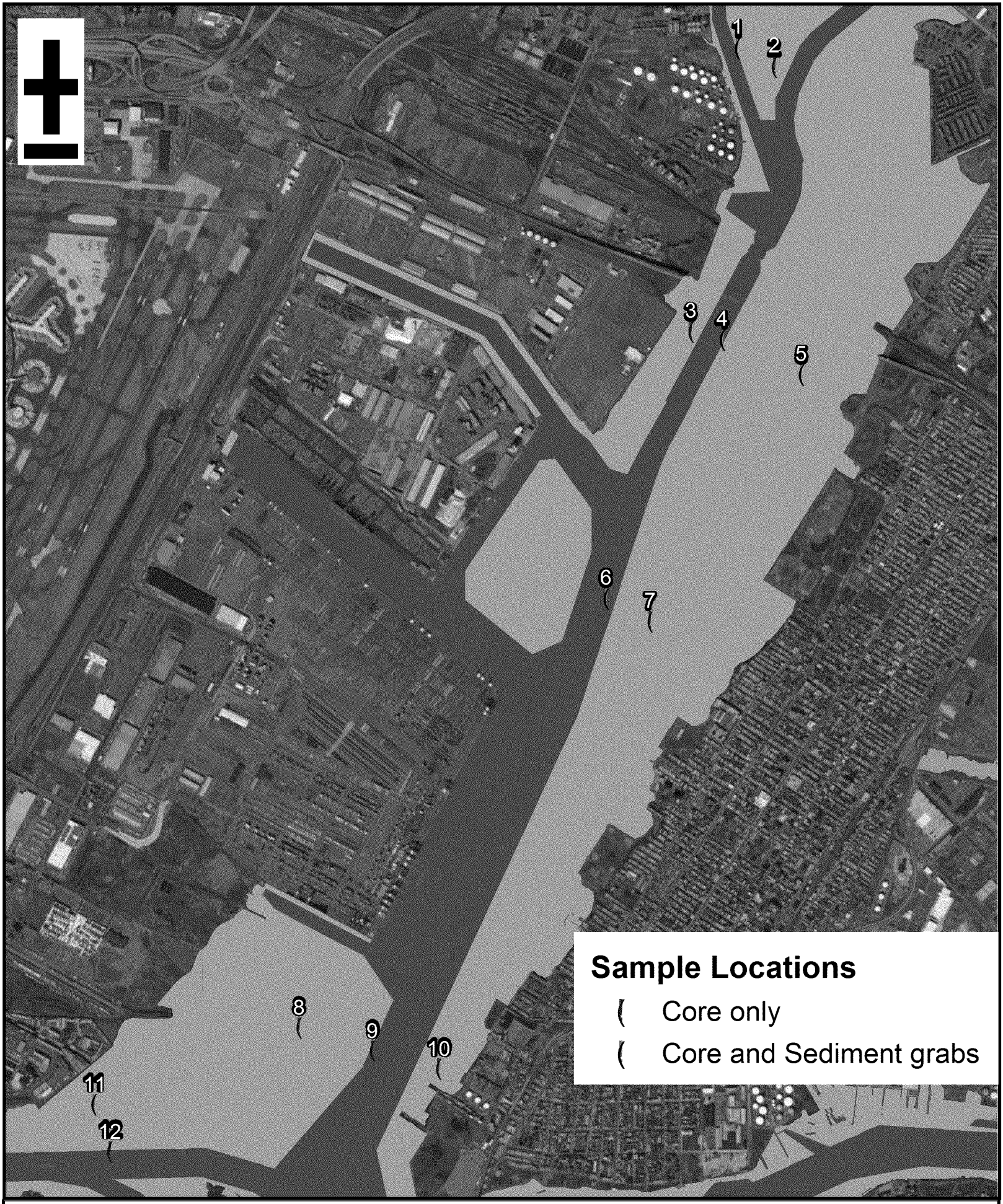
QAPP Worksheet 37
Usability Assessment

Usability Assessment (Worksheet 37)
Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: Refer to Worksheet 36 for data verification.
Describe the evaluative procedures used to assess overall measurement error associated with the project: As part of the data verification process, the data verifier identifies any qualifications, the bias, if known, of the data, applies comments on the usability of the data. Any QA/QC problems with the verification will be discussed with the laboratories.
Identify the personnel responsible for performing the usability assessment: The usability of the data is the responsibility of the project team. The Project Manager will assign technical staff to perform the split sample comparison after the data has been validated and reviewed.

Figure 1 Organization Chart
The Louis Berger Group, Inc.
Contract:
W912DQ-11-D-3009, T.O. 0006
Date prepared: 10 Nov 2010
Date revised: 10 Sep 2012



Notes:
1. Day-to-day lead duties on administrative requirements.
2. Day-to-day lead duties on deliverable technical quality reviews.



HDR | HydroQual

Sources:
Aerial Photograph: (c) Microsoft Corporation and its data suppliers

Fig. 2 Core and Sediment Sample Locations

ATTACHMENT 1

STANDARD OPERATING PROCEDURE (SOP) NO. 1 FOR NEWARK BAY SEDIMENT EROSION MEASUREMENT PROGRAM – A SEDFLUME STUDY

1.0 INTRODUCTION

This Standard Operating Procedure (SOP) was prepared to direct field personnel in the implementation of the Sediment Erosion and Deposition Flume (SEDFlume) sediment erosion rate study for the Newark Bay Study Area (NBSA) RI/FS. Twenty-four (24) sediment cores will be collected on-site and processed at a nearby facility (80 Lister Avenue, Newark, NJ) to measure in situ erosion rate characteristics. In addition, surface sediments will be collected from specific locations in the NBSA for a sediment slurry consolidation evaluation (a 30-core assessment).

Erosion rates of the core sediment with depth will be measured directly with SEDFlume. Sediment cores of approximately 50-60 cm in length (target length) will be recovered, if feasible. The direct measurement of sediment erosion rates via SEDFlume provides a quantitative measurement of sediment stability that can be used to determine the potential for sediment mobility in a natural system (McNeil et al., 1996). It has additionally been demonstrated that erosion rates are strongly dependent on the bulk density of the sediments (Jepsen et. al, 1997; Roberts et. al, 1978). Because of this, the densities of the SEDFlume cores will be determined by sub-sampling locations within each core so that the bulk density can be determined through wet/dry sample weight. Particle size analysis will be performed by processing sediments collected from the same locations in the cores to provide additional characterization of the sediments. The core locations will be specified so as to delineate morphologic regions and encompass ranges of particle size distributions, contamination concentrations and anticipated bed shear stresses (determined via numerical modeling).

1.1 Objective

A primary objective of the SEDFlume study is to directly measure sediment erosion rates and sediment bulk properties to determine the potential for erosion of sediments in specific areas of interest.

1.2 Referenced Documents

- Sea Engineering, Inc. SEDFlume Erosion Rate Measurement Manual
- Sea Engineering, Inc. Standard Laboratory Procedures for Measurement of Water Content
- Sea Engineering, Inc. Quality Assurance Manual
- Sea Engineering, Inc. Coring Instructions
- Sea Engineering, Inc. Sedflume Data Worksheets

1.3 Equipment Requirements

1.3.1 Documentation Equipment

- Waterproof field logbooks
- Sample log forms
- Field log forms
- Equipment manuals
- Sample labels
- Writing tools (i.e., waterproof pens, Sharpie®, etc.)
- Digital camera

1.3.2 Task-Specific Equipment

- Personal protective equipment (PPE) as required by the project-specific Health and Safety Plan (HASP)
- Flashlights (preferably head flashlight) or work-place lights
- Powder-free nitrile gloves
- Decontamination equipment (project-specific)
- Paper towels
- Trash bags (one for IDW and one for general trash)
- Marine vessel
- Ponar dredge grab sampler
- Mapping-grade GPS (differential GPS at a minimum), for recording sample locations or navigating to pre-determined locations. GPS shall be capable of horizontal positioning within 1 meter.
- Standard SEDFlume Coring Rig (includes push coring gear and core barrels)
- Laptop computer
- SEDFlume Mobile Laboratory (detailed in SEDFlume laboratory documentation)
- SEDFLume Stationary Laboratory (for Core Analysis in Santa Cruz, CA)

1.4 Installation and Preparation Tasks

- Assemble field equipment
- Travel to surface sediment collection locations and collect sediment via grab sample
- Ship surface sediment back to Santa Cruz laboratory
- Travel to coring locations and obtain field cores

- Deliver field cores to mobile SEDFlume laboratory
- Analyze field cores
- Slurry consolidation cores in Santa Cruz Laboratory
- Analyze consolidation cores

2.0 DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

To achieve the project's overall data quality objectives, measurements will be made to ensure sufficient characterization of sediment bulk properties and erosion rates. The bulk properties to be measured by SEI have been chosen based on previously determined field and laboratory work (McNeil et al, 1996; Taylor et al, 1996; Jepsen et al, 1997; and Roberts et al, 1998). The parameters to be measured in the SEDFlume cores are listed in Table1.

Table 1

Measurement	Definition	Units	Detection Limit
Bulk Density, ρ_b (wet/dry weight)	$\rho_b = \frac{\rho_w \rho_s}{\rho_w + (\rho_s - \rho_w)W}$	g/cm^3	Same as water content
Water Content	$W = \frac{M_w - M_d}{M_w}$	unit less	0.1g in sample weight ranging from 10 to 50 g
Particle Size Distribution	Distribution of particle sizes by volume percentage using laser diffraction	μm	0.04 μm – 2000 μm
Erosion Rate	$E = \Delta z/T$	cm/s	$\Delta z > 0.5$mm $T > 15$s

M_w = wet weight of sample
M_d = dry weight of sample
Δz = amount of sediment eroded
T = time
ρ_w = density of water
ρ_s = density of sediments
All essential bulk properties will be measured from the same core.

3.0 FIELD METHODS

3.1 Sampling Process Designs

Sediment erosion rates will be determined horizontally and depth-wise. Erosion rates will be measured as a function of shear stress and depth for each sediment core. Sediment bulk properties will also be measured for each erosion core. Bulk properties of the sediments (particle size distribution, organic content and bulk density) will be measured using samples from the erosion core. All essential bulk properties (including erosion rates) will be measured for the same core using this method. All measurements to be taken (Table 1) are classified as critical measurements.

Twenty-four (24) cores will be processed on-site in the SEDFlume to determine how sediment erosion potential and bulk parameters vary spatially in the study area. In addition, approximately 30 slurry cores will be prepared from surface sediments collected from 5 locations. The slurries will be placed in SEDFlume core barrels, allowed to consolidate for a specified duration, and processed in the Sea Engineering, Inc. (SEI) laboratory in Santa Cruz, CA. The total number of cores chosen represents the number expected to be required to characterize the different sediment types that exist in the region and their spatial variation, while not making the study's duration prohibitively long.

Approximately two cores can be processed per day in SEDFlume, so 24 cores represents approximately two weeks in the field. Approximately 5 weeks of processing time will be required to process the slurry cores in the Santa Cruz, CA, laboratory. Erosion rates are dependent upon, at least, the following parameters: bulk density, mean grain size, grain size distribution, material specific gravity, gas content and organic content. Sediment erosion cannot, at present, be predicted through specific knowledge of bulk parameters. Therefore, a sufficient number of cores are necessary to present adequate average erosion rates for a given aquatic system.

Coring locations will be chosen with the following criteria: a) sediments known to contain a relatively large amount of contaminant must be characterized, b) a wide variety of sediment types commonly found in the area, c) knowledge of sediment variability both spatially and with water depth is necessary as sediment re-suspension and deposition are strong functions of applied shear stress and water depth, and d) a wide range of near-bed shear stresses that may cause sediment re-suspension and transport. Using the above criterion as guidelines, coring locations will be selected as appropriate.

3.2 Core Collection and Preparation

In situ coring will be done in the following manner aboard the vessel selected for coring. Cores will be collected for SEDFlume testing from twelve locations in the Newark Bay Study Area (NBSA). Two cores will be collected from each sampling location. Proposed sampling locations for field cores and proposed grab sample locations for slurry cores are shown in Figure 2 of the Newark Bay Erosion Rates Testing QAPP. Sample location of field cores and

surface sediments will be finalized prior to project initiation. The locations for the cores were selected to provide good spatial resolution and a representative characterization of sediment types and sediment bed morphology present in the system.

Prior to collection of the sediment core at a given location, a coring assembly will be prepared by inserting a core tube into a thin stainless steel sleeve. The assembled coring sleeve will then be lowered to the sediment bed by a pole. Pressure will be applied to the top of the coring pole such that the sleeve penetrates into the sediment bed. The coring sleeve will be pushed as far as possible into the sediment bed; the distance of penetration will vary due to the characteristics of the sediment (i.e., further penetration will occur in a softer sediment than in a more compact sediment). This insures a relatively undisturbed sediment core. Sediment cores varying in length from 25 to 60 cm will be obtained by this method.

Cores will immediately be visually inspected for length and quality. Sediments that show signs of disturbance during the coring process will be discarded and another core will be taken from that location. Approved cores will be capped and stored upright until returned to the on-shore processing site. If deemed necessary, cores will be stored in a padded container to minimize disturbance while on board the vessel.

At the processing site, samples will be taken from the core for bulk property analysis and placed in appropriate sized containers, labeled, sealed, and preserved until delivered to the laboratory for analysis. All samples will be uniquely labeled and logged by the sampler. Samples designated for SEDFlume study will be under continuous custody so the sample integrity can be assured until the SEDFlume testing is completed. Jason Magalen, P.E. will be responsible for corrective action regarding sample method requirements.

3.3 Sample Handling and Custody Requirements

Samples will be collected, handled, and analyzed by SEI personnel.

All samples will be uniquely labeled and logged by the sampler. Samples designated for SEDFlume study will be under the continuous custody of SEI personnel so the sample integrity can be assured. Jason Magalen, P.E., of SEI will supervise all SEDFlume operations.

4.0 ANALYTIC METHODS

4.1 Description of SEDFlume

A detailed description of SEDFlume and its application are given by McNeil et al. (1996). SEDFlume is shown in Figure 1 of this SOP and is essentially a straight flume that has a test section with an open bottom through which a rectangular cross-section coring tube containing sediment can be inserted. The main components of the flume are the coring tube; the test section; an inlet section for uniform, fully-developed, turbulent flow; a flow exit section; a water storage tank; and a pump to force water through the system. The coring tube, test section, inlet section, and exit section are made of clear acrylic so that the sediment-water interactions can be observed. The coring tube shown in Figure 1 has a rectangular cross-section, 10 cm by 15 cm, and can be up to 1 m in length. SEI additionally uses a 10 cm diameter

circular core for SEDFlume analysis to facilitate field collection of cores, when necessary.

Water is pumped through the system from a 300 gallon storage tank, through a 5 cm diameter pipe, and then through a flow converter into the rectangular duct shown. This duct is 2 cm in height, 10 cm in width, and 120 cm in length; it connects to the test section, which has the same cross-sectional area and is 15 cm long. The flow converter changes the shape of the cross-section from circular to the rectangular duct shape while maintaining a constant cross-sectional area. A valve regulates the flow rate in the system. Also, there is a small valve in the duct immediately downstream from the test section that is opened at higher flow rates to keep the pressure in the duct and over the test section at atmospheric conditions.

At the start of each test, the coring tube and the sediment contained within it are inserted into the bottom of the SEDFlume test section. An operator moves the sediment upward using a piston that is inside the coring tube and is connected to a screw jack with a hand drive. The jack is driven by either electric motor or hand crank. By these means, the sediments can be raised and made level with the bottom of the test section. The speed of the jack movement can be controlled at a variable rate in measurable increments as small as 0.5 mm.

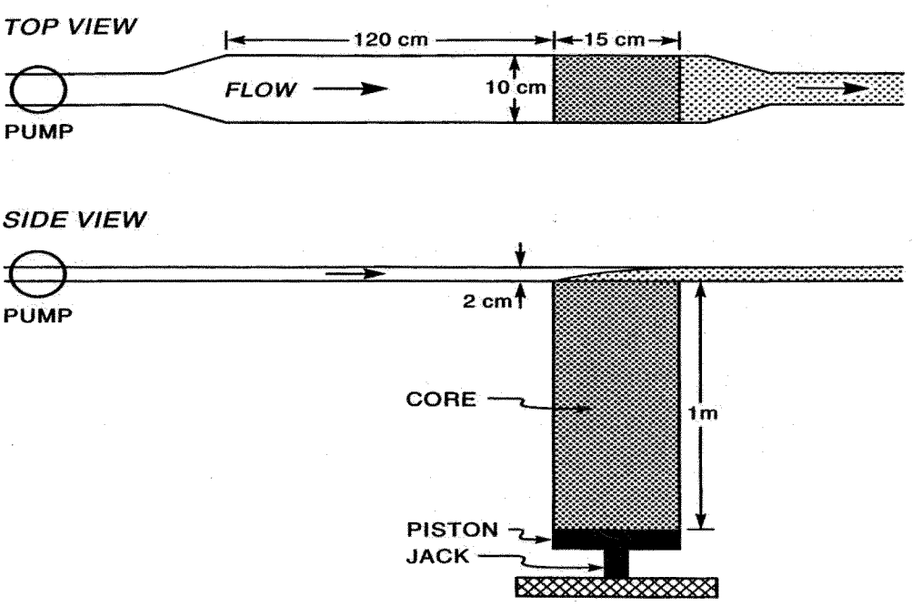


Figure 1. Schematic of SEDFlume

Water is forced through the duct and the test section over the surface of the sediments. The shear produced by this flow causes the sediments to erode. As the sediments in the core erode, they are continually moved upwards by the operator so that the sediment-water interface remains level with the bottom of the test and inlet sections. The erosion rate is recorded as the upward movement of the sediments in the coring tube over time.

4.2 Measurements of Sediment Erosion Rates

The procedure for measuring the erosion rates of the sediments as a function of shear stress and depth is described herein. The sediment cores will be obtained from the site and prepared as described above. Once the core barrel and sediment are secured in the SEDFlume test section, the sediment will be moved upward into the test section until the sediment surface is even with the bottom of the test section. A measurement is made of the depth to the bottom of the sediment in the core, which denotes the initial starting level. The flume is then run at a specific flow rate corresponding to a particular shear stress. As sediment erodes, the sediment surface is kept level with the bottom of the test section by raising the surface level as necessary. Erosion rates are obtained by measuring the remaining core length at different time intervals, taking the difference between each successive measurement, and dividing by the time interval.

To measure erosion rates at several different shear stresses using only one core, the following procedure is used. Starting at a low shear stress, the flume is run sequentially at higher shear stresses with each succeeding shear stress being twice the previous one. Generally at least three shear stresses are run sequentially, if feasible. Each shear stress is run until at least 1 to 3 mm but no more than 2 cm are eroded. The time interval is recorded for each run with a stopwatch. The flow rate is subsequently increased (i.e. the applied shear stress) until at least 3 measureable erosion rates are obtained (if feasible). This cycle is repeated until all of the sediment has eroded from the core. If after three cycles a particular shear stress shows a rate of erosion less than 10^{-4} cm/s, it will be dropped from the cycle; if after many cycles the erosion rates decrease significantly, a higher shear stress will be included in the cycle.

4.3 Measurements of Critical Shear Stress for Erosion

A critical shear stress can be quantitatively defined as the shear stress at which a very small, but accurately measurable, rate of erosion occurs. In the present study, this rate of erosion is chosen to be 10^{-4} cm/s; this represents 1 mm of erosion in approximately 15 minutes. Since it would be difficult to measure all critical shear stresses at exactly 10^{-4} cm/s, erosion rates are generally measured above and below 10^{-4} cm/s at shear stresses which differ by a factor of two. The critical shear stress is then linearly interpolated to an erosion rate of 10^{-4} cm/s. Critical shear stresses are also determined via a power law regression fit (Roberts et al., 1998). Critical shear stresses will be measured as a function of depth for both the field and the slurry sediment cores.

4.4 Measurements of Sediment Bulk Properties

Particle size and bulk density measurements will be conducted using standard laboratory analysis. Particle size and bulk density will be determined for field and slurry sediment cores. These will be detailed in later documents.

4.5 Quality Control Requirements

Although great care will always be taken, quality control will be performed routinely during sampling and measuring.

Sediment erosion rates are related to shear stresses that are applied at particular flow rates in the channel of the SEDFlume. The initial flow rate used will be that at which sediment erosion is observed to begin. The flow rates, as measured by the flow meter, will be checked daily by directly measuring the volume of water collected over time at the outlet of the channel. If the flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this does not correct the problem, a new flow meter will be installed.

All instruments used for bulk density analysis will be tested with standard methods before and after each testing period.

Particle size measurements will be run in triplicate to check for accuracy. Also, known particle size standards will be measured before and after each testing period.

4.6 Instrument/Equipment Testing, Inspection and Maintenance Requirements

The SEDFlume flow rates and all instrumentation will be tested daily before each test run. The particle size measurements will be tested against known standards.

SEDFlume is designed as a field device and as such is a rugged system. Spare parts for SEDFlume and for the coring operation are either available at any hardware store, or may be made by any competent machine shop.

4.7 Instrument Calibration and Frequency

No instruments used in the SEDFlume study require calibration. All instruments will be tested as described previously.

5.0 GENERAL REQUIREMENTS

5.1 Documentation

Activities conducted as part of this SOP shall be documented in accordance with USEPA guidance, including a record of daily conditions and activities, sampling activities, and all other information required to be recorded per project directives.

5.2 Decontamination Procedures

Equipment will be decontaminated prior to shipment for repairs and at the conclusion of the field analysis. Decontamination shall be performed according to project specific directives. Personnel and PPE decontamination shall be performed in accordance with the project HASP.

5.3 Investigative Derived Waste

IDW, including decontamination fluids, used PPE, and other IDWs , generated during activities associated with this QAPP shall be handled and disposed of according to project specific directives.

6.0 REFERENCES

Jepsen, R., J. McNeil, and W. Lick, 1999. Effects of Gas Genera tion on the Density and Erosion of Sediments from the Grand River, Report, Department of Mechanical and Environmental Engineering, University of California, Santa Barbara, CA 93106.

Jepsen, R., J. Roberts, and W. Lick, 1997, Effects of Bulk Density on Sediment Erosion Rates, Water, Air, and Soil Pollution,Vol. 99, pp. 21-31.

McNeil, J., C. Taylor, and W. Lick, 1996, Measurements of Erosion of Undisturbed Bottom Sediments with Depth, J. Hydraulic Engineering, 122(6) pp. 316-324.

Roberts, J., R. Jepsen, and W. Lick, 1998, Effects of Particle Size and Bulk Density on the Erosion of Quartz Particles, J. Hydraulic Engineering, 124(12) pp. 1261-1267.

Taylor, C. and W. Lick, 1996, Erosion Properties of Great Lakes Sediments, UCSB Report.

ATTACHMENT 2

Sea Engineering, Inc.

Sedflume Sediment Grain Size Analysis Standard Laboratory Procedures

Approved by:_____Date_____
Jason Magalen
SEDFlume Task Leader

Approved by:_____Date_____
Ken Israel
Vice President/Technical Director

200 Washington Street, Suite 210
Santa Cruz, CA 95062
Ph: 831-421-0871 fax: 831-421-0875

OIXDATION OF ORGANIC MATTER

Materials

- 35% Hydrogen Peroxide
- Plastic stir rod
- Distilled water
- Watch glasses
- Tongs or think gloves
- Hotplate
- Sharpie

Procedure

- To the 1000ml beaker of representative sub-sample (5-10g) for grain size analysis:
  - Slowly add 10ml of 35% hydrogen peroxide (an exothermic reaction may occur)
  - Swirl or stir the sample with a plastic stir rod until disaggregated
  - If organic matter remains (plant fibers, wood, etc.) continue to add peroxide (large fragments of wood or mangrove stalks may be physically removed during wet sieve analysis)
  - Slowly add approximately 200-300ml of distilled water, or until beaker is full to the 400ml line
  - Cover beaker with a watch glass
  - Set samples aside for 24 hours
  - Label batch appropriately:
    - Name
    - Phone number
    - Molokai sand in hydrogen peroxide and distilled water
- 24 hours later:
  - Remove watch glass and return any fine particles present on watch glass to beaker
    - Rinse with distilled water into beaker
  - Set hot plate dial between 250 and 300 C
  - Place beakers on hot plate and bring to a boil
  - Simmer samples for 2-4 hours to remove any remaining hydrogen peroxide
  - Samples will froth and climb up the side of beaker:
    - Periodically wash sides of beaker, with distilled water, back into the simmering solution
    - **PRCAUTIONS:**
      - If samples jump and bounce around on hot plate: TURN DOWN HEAT!
      - Use care not to lose any fine particles by frothing over!
      - Use care not to bake sample to the bottom of the beaker!

- **WARNING:** The beaker will be very hot! Use tongs or thick gloves when handling!
- If large amounts of hydrogen peroxide were used, boil solution in fumehoods to safely remove hazardous vapors from the laboratory!

- Simmering is complete when water level has decreased to 100-150ml
- Turn hot plates off
- Remove beakers from hot plates and place on counter surface
- Allow samples to cool to room temperature

Cleanup

- Wash all labware with tap water and allow to dry
- Put away all labware when dry

PARTICLE SIZE SAMPLE PREPARATION PROCEDURE

Materials Required
Laboratory Sample Blender
Calgon Solution
Spoon/Spatula
Disposable Pipettes
Sharpie

Procedure

*****DO NOT CHANGE ANY OF THE PROGRAMS ON THE COMPUTER*****

1. Turn on computer and LS 13 320 and prepare new project
    a. Click on the LS 13 320 icon on the desktop computer
    b. To start a new simulation click run then click optical module (COM1)
    c. Click on sample info and enter the sample ID, file ID and operator then click ok
2. Click start icon (this takes a couple of minutes so start to prepare sample at the same time)
    a. For every run click
    -measure loading
    -start 3 runs
    -auto rinse
    b. If you are running more that one sample then every hour click
    -measure offsets
    -align
    -measure loading
    -start 3 runs
    -auto rinse
3. Prepare sample
    a. Sieve sample with 2000 micron sieve
    b. Pour sieved sample into laboratory blender with 750mL-1000mL of tap water
    c. Add 5mL of a 10% sodiumhexametaphosphate (calgon) solution to disperse negatively charged clay particles
    d. Blend sample for ~30 sec before adding it to the LS 13 320
4. Add sample to the LS 13 320
    a. Use a 5mL disposable pipette to add a sub-sample of material from the laboratory blender into LS 13 320 Aqueous Liquid Module when the computer is measure loading
    b. Observe obscuration on the LS 13 320 software screen and continue to add sample until obscuration reading is greater than 8%
    c. Click start analysis to begin sample cycle; the LS 13 320 will automatically run 3 tests and average the results

5. Once the test is done ensure the automatic flushing on the Aqueous Liquid Module clears the entire system
6. Verify that the sample data is present and saved (the data has 4 decimal places)
7. Between each sample wash the all the parts of the blender and sieve with tap water

Calculations

Calculations are of grain size are automatically done by the analyzer. It takes an average of 3 runs for each sample. This data is saved onto the computer under the file name of the job. Units are recorded to the 4^{th} decimal place.

Identification of the test method/ Summary of test methods

The purpose of these test methods is to prepare the sediment samples to be run through the Particle Size Analyzer. The purpose of the oxidation of organic matter procedure is to get rid of any organic matter in the sediment samples. Once the organic matter has been eliminated the sample is then ready for the Particle Size Sample Preparation Procedure.

Scope and application including components to be analyzed

The scope of this application is to determine the disaggregated particle size distribution of sediment sub-samples from sediment cores. This data is used in the analysis and reporting of sediment cores.

Method Performance/ Data assessment and acceptance criteria for control measures

Detection limits for the Particle Size analyzer are between 0.375 – 2000 microns. Acceptance criteria for quality control measures are validated by the standards. Any discontinuous particle size distributions will be flagged as erroneous.

Safety

Safety in the laboratory is the responsibility of every employee. All laboratory personnel are to familiarize themselves with the contents of this section and police other employees to be sure the procedures are being followed. Authorized visitors in the laboratory are also expected to be aware of and follow the procedures.

Under no circumstance are persons in the possession of or under the influence of mind altering drugs or alcohol permitted in the Sea Engineering office or its laboratory. Being under the influence of or in the possession of such drugs and/or the failure to report anyone under their influence or in their possession constitutes grounds for immediate dismissal. Details of this procedure are defined in the employees Employment Contract.

Drug and alcohol testing may be required by client companies. Employees are subject to the requirements and rules of client companies when working on client sites. These may include but are not limited to pre project drug testing, random testing and post accident investigation testing. Employees are expected to give full cooperation to client representatives conducting testing under their programs. Failure to cooperate with clients will be deemed as grounds for dismissal.

The proper choice of attire will enhance the effectiveness of safety equipment in the event of an accident. Bare feet or any form of open-topped shoes are not acceptable laboratory attire. Personnel are to wear gloves when handling contaminated sediments. Disposable gloves are provided by Sea Engineering.

The cleanliness of offices and laboratories is the responsibility of individuals working in those areas. Floors are to be kept free of filth and trash. The placement of supplies, equipment and personal items on the floor is to be avoided. Access to emergency equipment such as fire extinguishers shall not be obstructed. Waste and scrap shall be discarded in the appropriate provided containers.

Use caution when handling with the 35% Hydrogen Peroxide and the Calgon Solution. Wear gloves and safety goggles when handling these solutions and do not inhale, drink or spill on your skin. If these solutions happen to spill onto you wash the area thoroughly with water for 15 min and then call your local hospital if further treatment is deemed necessary.

Equipment and supplies

Equipment, materials and supplies that are necessary to complete analytical testing are provided by Sea Engineering, Inc. The purchase of materials, equipment and supplies which impact data quality is to be accomplished in such a way that a preset of defined quality and/or performance specifications is included as part of the bid package.

Equipment that has been subjected to overloading, mishandling or otherwise thought to be defective is taken out of service until the appropriate measures/repairs are completed and the instrument has been tested and calibrated to perform satisfactorily. Preventive maintenance procedures are to be prepared for each new piece of equipment acquired. This includes checking the calibration of each piece of equipment before each daily use. There are four logbooks, one for each piece of equipment, where before each daily use the analyst must log that they have calibrated the equipment.

Maintenance on the Particle Size Analyzer will only occur as needed. If the instrument fails to pass the control standards then we will consult the user manual and the proper action will be taken.

Reagents and Standards

The reagents used in these procedures (hydrogen peroxide and calgon solution) are kept in sealed containers away from any material that could potentially react with them. Only handle while wearing gloves and safety goggles.

The standards for the Particle Size Analyzer are particles with certified sizes that are used for the calibration of the equipment. These standards are kept in the drawer directly below the computer attached to the Particle Size Analyzer.

While the instrument manual states that tap water needs to be filtered and de-gassed a discussion with the manufacturer stated that if backgrounds are clear prior to each sample analysis these steps do not need to be taken. This is done in step 2 of the procedure.

Sample collection, preservation, storage, handling and chain of custody

Samples will be collected, handled, and analyzed by SEI personnel. However sometimes the client will send us samples they have collected and want us to analyze. Chain of custody will be recorded as required by project specifications.

All samples are uniquely labeled and logged by the sampler. Samples designated for particle size analysis will be under the continuous custody of SEI personnel so the sample integrity can be assured. Jason Magalen, P.E., of SEI will supervise all Sedflume operations. Holding time before analysis of samples is 28 days unless otherwise discussed between SEI employees and the client. After analysis samples will be stored in the lab until the final report has been sent to the client.

Quality control/ Calibration/Record keeping and record storage (archives)

Although great care will always be taken, quality control will be performed routinely during sampling and measuring.

Before each daily use the analyst will run a standard (35micron particles) and log the date, time, standard used and its serial number along with any notes in the Particle Size Analyzer logbook. This is to ensure that the Particle Size Analyzer is working properly. Also if the analyst is running more than one sample (which is mostly the case) then every hour the analyst should run quality control by clicking measure background (see particle size sample preparation procedures step 2). The computer will remind you when these checks should occur. Complete calibration procedures for the Particle Size Analyzer are found in the Particle Size Analyzer Manual binder.

While the Particle Size Analyzer is analyzing the 3 runs the analyst should look at the histograms produced at the end of this cycle. If the two lines separated by 1% or less than the analysis is good.

All the data generated by the Particle Size Analyzer is uniquely identified. The data generated by each sample is saved according to the sample ID number and placed into a file with the job # and/or title. These files are then transferred to a USB to be brought up

to the office for further analysis. These files are never allowed to be transferred by people outside of SEI and are saved onto our company server. These data files are also printed out kept in the appropriate job file found in the Sedflume filing cabinet in the SEI office. It states very clearly at the beginning of the procedures that no one is to change the program settings on the Particle Size Analyzer.

Inventory procedures

Who ever notices supplies running low in the lab it is their responsibility to order more supplies. A general supply check takes place before any analysis begins to make sure that SEI has the supplies needed.

Data Review, Validation and Verification Requirements

This section describes the statistical assessment procedures that are applied to the data and the general assessment of the data quality accomplishments. This is only performed on replicate cores.

Precision

The precision will be evaluated by performing duplicate analyses and will be assessed by the following three methods:

1) Difference

$$\text{Difference} = X_1 - X_2$$

Where: X_1 = larger of the two observed values
X_2 = smaller of the two observed values

2) Relative Percent Difference (RPD)

$$\text{RPD} = \frac{(X_1 - X_2) \cdot 100}{(X_1 + X_2)/2}$$

3) Relative Standard Deviation (RSD)

$$\text{RSD} = (s/\bar{y}) * 100$$

Where: s= standard deviation
$\bar{y}$ = mean replicate analyses

This formula is used for three or more replicate values and may be used when reporting precision on aggregated data.

Standard deviation is defined as follows:

$$s = \sqrt{\sum_{n=1}^{n} \frac{(y_i - \bar{y})^2}{(n-1)}}$$

Where: y_i = measured value of the ith replicate
$\bar{y}$ = mean of replicate analyses
n = number of replicates

Accuracy

Accuracy will be based upon known samples or reference. Field and laboratory blank samples can also be used in the assessment of accuracy.

Accuracy will be evaluated by determining whether the samples are within the required acceptance windows. Bias for a particular sample is defined:

$$Bias = \frac{\sum (Y_{ik} - R_i)}{n}$$

Where: Y_{ik} = the average observed value for the ith audit sample and k observations
R_i = the theoretical reference value
n = the number of reference samples used in the assessment

Comparability

Comparability will be assessed through the evaluation of precision and accuracy estimates of samples. Replicates of at least four samples will be taken from each of four sites to demonstrate comparability.

Detectability

An important factor to consider in data quality evaluations is the detection limit, which is defined as the lowest value of a characteristic that a measurement process, or a method specific procedure can reliably discern. Detection limits are defined in general as:

Detection Limit = $t_{(n-1,1-\alpha=.99)}$*s

Where: $t_{(n-1,1-\alpha=.99)}$ = researcher's t-value for a one sided 99% confidence level and standard deviation estimate with n-1 degrees of freedom.
s = standard deviation

Sedflume field data is not amenable to statistical analysis. Grain sizes vary both aerially and with depth and thus no two measurements should be necessarily similar. Note that grain sizes can vary by as much as five orders of magnitude for a given core. In each

case there is no theoretically achievable value and as such, accuracy is an unsuitable criterion. Precision is a proper criterion only when evaluating replicates and split duplicates. Split duplicates may be obtained for bulk parameters; however, split duplicates are not possible for erosion rates.

Completeness will be assessed for each variable upon completion of the measurements. There is ample time in the field for obtaining a second core from a given site if there are problems with processing the initial core.

Data that is determined to be inaccurate, incomplete, or non-detectable will either be rejected or presented with clear notification of data deficiency.

Pollution Prevention/Waste Management/Management of laboratory wastes and hazardous materials

When dealing with contaminated sediments great care is taken to prevent spillage. If some spillage occurs it is cleaned up immediately using the proper cleaning agents. All contaminated sediments and water are dumped into large water containers on the outside of the laboratory. These containers are emptied by a designated pollution/waste company when the job is completed and/or when the containers are full.

Non-contaminated liquid and sediment waste materials are simply washed down the sink. Non-contaminated solid wastes (i.e. paper towels) are thrown into designated trash bins and emptied when full.

Corrective Action

Whenever an out of control situation has been detected, the analyst should notify his supervisor and together try to resolve the problem which caused the situation. After resolution, the analyst should continue with the corrective action to bring the analysis back in control. Usually this means repreparing and/or reanalyzing the samples. When sample or time limitations (rush work) preclude correcting the situation, discuss with the QAU, notify client and flag the out of control data. For every situation that requires a corrective action, the analyst will fill out a corrective action form found in the Quality Assurance Manual. Once the corrective action has been put in place and the form has been signed and filed the corrective action must be monitored for its effectiveness.

Correcting erroneous reports

The client will immediately be notified of any errors in our reports. They will receive a detailed description of the error with the appropriate correction.

Complaint Resolution

Anytime a serious complaint is received, it is recorded for a permanent record, tracked to insure resolution, and brought to the attention of senior managers. A serious complaint is

one that questions the validity of our results. In general, the nature of the complaint is documented on a form which is given to the Vice President/Technical Director or Laboratory Manager. Someone is assigned to resolve the issues and monitor for its effectiveness. The progress of the complaint resolution is discussed and tracked during weekly staff meetings. Finally, after resolution, the client is contacted for final comments, and the complaint form is signed off by a second senior manager. A permanent record is kept by the Quality Assurance Manager. A Client Complaint Record or similar form will be used to record the complaint which can be found in the Quality Assurance Manual.

References

Particle Size Analyzer Instruction Binder

Sea Engineering, Inc.

Standard Laboratory Procedures for Measurement of Water Content

Revisions to 1.3:
Balance verification is conducted with 1g and 50g.

Approved by:_____
Jason Magalen
SEDFlume Task Leader

Approved by:_____
Ken Israel
Vice President/Technical Director

200 Washington Street, Suite 210
Santa Cruz, CA 95062
Ph: 831-421-0871 fax: 831-421-0875

Materials
Drying oven
Balance
Disposable metal sampling trays
Tongs

Sampling Procedure

1. Determine and record the mass of a clean and dry disposable metal sampling tray (to 3 decimal places) on the Bulk Density Datasheet found in the Sedflume Logbook
2. Place moist sample (5-10g) on the tray and determine the mass of the tray and sample using the balance and record this value (to 3 decimal places)
3. Place the tray with the sample in the drying oven at 110 ± 5°C for a minimum of 12 hours
4. After the sample has dried remove the tray from the oven with tongs and place on the counter next to the oven to cool
5. Allow to cool to room temperature or until the try can be handled comfortably with bare hands and the operation of the balance will not be affected by convection currents and/or being heated
6. Determine the mass of the tray and oven-dried sample using the same balance used in step 1 & 2 and record this value (to 3 decimal places)
7. Repeat steps 3-6 two more times to make sure the sample has reached a constant dry mass

*Record all weights onto the Bulk Density Datasheet found in the Sedflume Logbook

Calculations

1. Calculate the water content of the samples as follows:

$w = [(M_{tms} - M_{tds})/(M_{tds} - M_t)] \text{ X } 100 = M_w/M_s$

w = water content, %
M_{tms} = mass of tray and moist sample, g
M_{tds} = mass of tray and oven dry sample, g
M_t = mass of tray, g
M_w = mass of water ($M_w = M_{tms} - M_{tds}$), g
M_s = mass of oven dry sample ($M_s = M_{tds} - M_t$), g

2. Calculate bulk density of the samples as follows:

$\rho_{sed} (\rho_{water})/ \rho_{sed} - [(\rho_{sed} - \rho_{water}) w] =$ bulk density

ρ_{sed} = density of Quartz, 2.65 g/cm3 (assume as a constant)
ρ_{water} = density of water, 1.00 g/cm3

w = water content, % (determined from calculation 1 for each sample)

Identification of the test method/ Summary of test methods

A sediment sample is dried in an oven at a temperature of 110 ± 5°C to a constant mass. The loss of mass due to drying is considered to be water. The water content is calculated using the mass of water and the mass of the dry sediment sample.

Scope and application including components to be analyze
The scope of this application is to determine the water content and bulk density of various sediment samples. This data is used in the analysis and reporting of sediment cores.

Method Performance/ Data assessment and acceptance criteria for control measures

Detection limits are as follows; oven temperature 110 ± 5°C and balance ± 0.0003g of certified standards. If all detection limits are met and equipment is calibrated and verified properly then acceptance criteria for control measures are verified.

Definitions

Water content by mass (of a sediment sample) - the ratio of the mass of water contained in the pore spaces of the sediment, to the solid mass particles of that sediment, expressed as a percentage. A standard temperature of 110 ± 5°C is used to determine these masses.

Constant dry mass (of sediment sample) – the state that a water content sample has attained when further heating causes, or would cause, less that 1% additional loss in mass. The time required to obtain constant dry mass will vary depending on numerous factors. The influence of these factors generally can be established by good judgment, and experience with the materials being tested and the apparatus being used.

Bulk density – weight of a unit volume of a loose material (such as a powder or soil) to the same volume of water. Expressed in grams per cubic centimeters (g/cm3)

Safety

Safety in the laboratory is the responsibility of every employee. All laboratory personnel are to familiarize themselves with the contents of this section and police other employees to be sure the procedures are being followed. Authorized visitors in the laboratory are also expected to be aware of and follow the procedures.

Under no circumstance are persons in the possession of or under the influence of mind altering drugs or alcohol permitted in the Sea Engineering office or its laboratory. Being under the influence of or in the possession of such drugs and/or the failure to report anyone under their influence or in their possession constitutes grounds for immediate dismissal. Details of this procedure are defined in the employees Employment Contract.

Drug and alcohol testing may be required by client companies. Employees are subject to the requirements and rules of client companies when working on client sites. These may include but are not limited to pre project drug testing, random testing and post accident investigation testing. Employees are expected to give full cooperation to client representatives conducting testing under their programs. Failure to cooperate with clients will be deemed as grounds for dismissal.

The proper choice of attire will enhance the effectiveness of safety equipment in the event of an accident. Bare feet or any form of open-topped shoes are not acceptable laboratory attire. Personnel are to wear gloves when handling contaminated sediments. Disposable gloves are provided by Sea Engineering.

The cleanliness of offices and laboratories is the responsibility of individuals working in those areas. Floors are to be kept free of filth and trash. The placement of supplies, equipment and personal items on the floor is to be avoided. Access to emergency equipment such as fire extinguishers shall not be obstructed. Waste and scrap shall be discarded in the appropriate provided containers.

Equipment and supplies

Equipment, materials and supplies that are necessary to complete analytical testing are provided by Sea Engineering, Inc. The purchase of materials, equipment and supplies which impact data quality is to be accomplished in such a way that a preset of defined quality and/or performance specifications is included as part of the bid package.

Equipment that has been subjected to overloading, mishandling or otherwise thought to be defective is taken out of service until the appropriate measures/repairs are completed and the instrument has been tested and calibrated to perform satisfactorily. Preventive maintenance procedures are to be prepared for each new piece of equipment acquired. This includes checking the calibration of each piece of equipment before each daily use. There are four logbooks, one for each piece of equipment, where before each daily use the analyst must log that they have calibrated the equipment.

Reagents and Standards

No reagents are needed for this procedure. The oven has a NIST traceable thermometer and the balance has a certified 1g and 50g weight. The standard temperature the oven should be set at is $110 \pm 5^{\circ}C$.

Sample collection, preservation, storage, handling and chain of custody

Samples will be collected, handled, and analyzed by SEI personnel. However sometimes the client will send us samples they have collected and want us to analyze. Chain of custody will be recorded as required by project specifications.

All samples will be uniquely labeled and logged by the sampler. Sediment samples are placed into small plastic bags and labeled with a unique ID number. It is this ID number that is logged onto the various datasheets. Samples designated for particle size analysis will be under the continuous custody of SEI personnel so the sample integrity can be assured. Jason Magalen, P.E., of SEI will supervise all Sedflume operations. Holding time before analysis of samples is 28 days unless otherwise discussed between SEI employees and the client. After analysis samples will be stored in the lab until the final report has been sent to the client.

Quality control/ Calibration/Record keeping and record storage (archives)

Although great care will always be taken, quality control will be performed routinely during sampling and measuring.

Before each daily use the analyst will calibrate the balance with the certified 1g and 50g weight and record the date, time and weight displayed on the screen onto the Balance Log Sheet found in the Balance Logbook. Before each daily use the analyst will calibrate the oven with the NIST certified thermometer and record the date, time and temperature onto the Oven Log Sheet found in the Oven Logbook.

The water content data is recorded onto the Bulk Density Datasheet found in the Sedflume Logbook. These datasheets are kept in the appropriate job file found in the Sedflume filing cabinet in the SEI office.

Inventory procedures

Who ever notices supplies running low in the lab it is their responsibility to order more supplies. A general supply check takes place before any analysis begins to make sure that SEI has the supplies needed.

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Where: s= standard deviation
$\bar{y}$ = mean replicate analyses

This formula is used for three or more replicate values and may be used when reporting precision on aggregated data.

Standard deviation is defined as follows:

$$s = \sqrt{\sum_{n=1}^{n} \frac{(y_i - \bar{y})^2}{(n-1)}}$$

Where: y_i = measured value of the ith replicate
$\bar{y}$ = mean of replicate analyses
n = number of replicates

Accuracy

Accuracy will be based upon known samples or reference. Field and laboratory blank samples can also be used in the assessment of accuracy.

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Data that is determined to be inaccurate, incomplete, or non-detectable will either be rejected or presented with clear notification of data deficiency.

Pollution Prevention/Waste Management/Management of laboratory wastes and hazardous materials

When dealing with contaminated sediments great care is taken to prevent spillage. If some spillage occurs it is cleaned up immediately using the proper cleaning agents. All contaminated sediments and water are dumped into large water containers on the outside of the laboratory. Disposable metal trays that contained contaminated sediments are rinsed with water before being thrown away. This water goes into the large water containers. These containers are emptied by a designated pollution/waste company when the job is completed and/or when the containers are full.

Non-contaminated liquid and sediment waste materials are simply washed down the sink. Non-contaminated solid wastes (i.e. paper towels) are thrown into designated trash bins and emptied when full.

Corrective Action

Whenever an out of control situation has been detected, the analyst should notify his supervisor and together try to resolve the problem which caused the situation. After resolution, the analyst should continue with the corrective action to bring the analysis back in control. Usually this means repreparing and/or reanalyzing the samples. When sample or time limitations (rush work) preclude correcting the situation, discuss with the QAU, notify client and flag the out of control data. For every situation that requires a corrective action, the analyst will fill out a corrective action form found in the Quality Assurance Manual. Once the corrective action has been put in place and the form has been signed and filed the corrective action must be monitored for its effectiveness.

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The client will immediately be notified of any errors in our reports. They will receive a detailed description of the error with the appropriate correction.

Complaint Resolution

Anytime a serious complaint is received, it is recorded for a permanent record, tracked to insure resolution, and brought to the attention of senior managers. A serious complaint is one that questions the validity of our results. In general, the nature of the complaint is documented on a form which is given to the Vice President/Technical Director or Laboratory Manager. Someone is assigned to resolve the issues and monitor for its effectiveness. The progress of the complaint resolution is discussed and tracked during weekly staff meetings. Finally, after resolution, the client is contacted for final comments, and the complaint form is signed off by a second senior manager. A permanent record is kept by the Quality Assurance Manager. A Client Complaint Record or similar form will be used to record the complaint which can be found in the Quality Assurance Manual.

Reference

ASTM 2216-05 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Designation: D2974 - 07a

Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[1]

This standard is issued under the fixed designation D2974; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks.

1.1.1 Method A – moisture is determined by drying peat or organic sample at 105 °C.

1.1.2 Method B – Alternative moisture method which removes the total moisture in two steps: (1) evaporation of moisture at room temperature, (2) subsequent oven drying of air dried sample at 105 °C.

1.1.3 Method C – Ash content of a peat or organic soil sample is determined by igniting oven dried sample from moisture content determination in a muffle furnace at 440 °C.

1.1.4 Method D – Ash content of a peat or organic soil sample is determined by igniting oven dried sample from moisture content determination in a muffle furnace at 750 °C.

1.2 This test method should be used for geotechnical and general classification. In addition, the test method should be used when peats are being evaluated for use as a fuel.

1.3 The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard. Use Practice D6026 for determining significant digits to report.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D6026 Practice for Using Significant Digits in Geotechnical Data

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

3. Terminology

3.1 *Definitions:*

3.1.1 For common definitions of terms in this standard, refer to Terminology D653.

4. Summary of Test Methods

4.1 *Test Method A*—Moisture is determined by drying a peat or organic soil sample at 105°C. The moisture content is expressed either as a percent of the oven dry mass or of the as-received mass.

4.2 *Test Method B*—This is an alternative moisture method which removes the total moisture in two steps: (*1*) evaporation of moisture in air at room temperature (air-drying), and (*2*) the subsequent oven drying of the air-dried sample at 105°C. This method provides a more stable sample, the air-dried sample, when tests for nitrogen, pH, cation exchange, and the like are to be made.

4.3 *Test Methods C and D*—Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a muffle furnace at 440°C (Method C) or 750°C (Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample.

4.4 Organic matter is determined by subtracting percent ash content from one hundred.

5. Significance and Use

5.1 This test method can be used to determine the moisture content, ash content, and percent organic matter in soil.

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.22 on Soil as a Medium for Plant Growth.

Current edition approved March 15, 2007. Published May 2007. Originally approved in 1971. Last previous edition approved in 2007 as D2974 – 07. DOI: 10.1520/D2974-07A.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

5.2 The percent organic matter is important in the following: (1) classifying peat or other organic soil, (2) geotechnical and general classification purposes, and (3) when peats are being evaluated as a fuel

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Oven,* meeting the requirements of E145 and capable of being regulated to a constant temperature of 105 6 5°C.

6.2 The temperature of 105 °C is quite critical for organic soils. The oven should be checked for "hot spots" to avoid possible ignition of the specimen.

6.3 *Muffle Furnace,* capable of producing constant temperatures of 440 °C 6 22 °C and 750 °C 6 38°C

6.4 *Balance or Scale,* a balance or scale for determining the mass of the soil having a minimum capacity of 500 g and meeting the requirements of Standard D4753 for a balance or scale of 0.01 g readability.

6.5 *Rubber Sheet, Oil Cloth,* or other non-absorbent material.

6.6 *Evaporating Dishes,* of high silica or porcelain of not less than 100-mL capacity.

6.7 *Blender,* high-speed.

6.8 *Aluminum Foil,* heavy-duty.

6.9 *Porcelain Pan, Spoons,* and equipment of the like.

6.10 *Desiccator.*

7. Sampling and Test Specimens

7.1 Place a representative field sample on a rubber sheet, oil cloth, or equivalent material and mix thoroughly.

7.2 Reduce the sample to the quantity required for a test specimen by quartering.

7.3 Place the test specimen and the remaining sample in separate waterproof containers.

7.4 Work rapidly to prevent moisture loss or perform the operation in a room with a high humidity.

8. Procedure

8.1 *Moisture Content Determination*

8.1.1 *Test Method A*

8.1.1.1 Record to the nearest 0.01 g the mass of a high silica or porcelain evaporating dish fitted with a heavy-duty aluminum foil cover. The dish shall have a capacity of not less than 100 mL.

8.1.1.2 Following the instruction in section 7.1 above, place a test specimen of at least 50 g in the container described in 8.1.1.1. Crush soft lumps with a spoon or spatula. The thickness of peat in the container should not exceed 3 cm.

8.1.1.3 Cover immediately with the aluminum foil cover and record the mass to the nearest 0.01 g.

8.1.1.4 Dry uncovered for at least 16 h at 105°C or until there is no change in mass of the sample after further drying periods in excess of 1 h. Remove from the oven, cover tightly, cool in a desiccator, and record the mass to the nearest 0.01 g.

8.1.2 *Calculations for Test Method A*

8.1.2.1 Calculate the moisture content as follows:

$$\text{Moisture Content, \%} = [(A - B)/B] \times 100 \quad (1)$$

where:

A = mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g.

8.1.2.1.1
This calculation is used primarily for agriculture, forestry, energy, and horticultural purposes and the result should be referred to as the moisture content as a percentage of as-received or total mass.

8.1.2.2 An alternative calculation is as follows:

$$\text{Moisture Content, \%} = [(A - B)/B] \times 100 \quad (2)$$

where:

A = mass of the as-received test specimen, g, and
B = mass of the oven-dried specimen, g.

8.1.2.2.1
This calculation is used primarily for geotechnical purposes and the result should be referred to as the moisture content as a percentage of oven-dried mass.

8.1.2.3 Take care to indicate the calculation method used.

8.1.3 *Test Method B*

8.1.3.1 This test method should be used if pH, nitrogen content, cation exchange capacity, and the like are to be tested.

8.1.3.2 Following the instructions in section 7.1 above, select a 100 to 300 g representative test specimen. Determine the mass of this test specimen to the nearest 0.01 g and spread it evenly on a large flat pan. Crush soft lumps with a spoon or spatula and let the sample come to moisture equilibrium with room air. This will require at least 24 h. Stir occasionally to maintain maximum air exposure of the entire sample. When there is no change in mass of the sample after further drying periods in excess of 1 h, calculate the moisture removed during air drying as a percentage of the as-received mass.

8.1.3.3 Grind a representative portion of the air-dried sample for 1 to 2 min in a high-speed blender. Use the ground portion for moisture, ash, nitrogen, cation exchange capacity tests, and the like.

8.1.3.4 Thoroughly mix the air-dried, ground sample. Weigh to the nearest 0.01 g the equivalent of 50 g of test specimen on an as-received basis. Determine the amount, in grams, of air-dried sample equivalent to 50 g of as-received sample, as follows:

$$\text{Equivalent Sample Mass, g} = 50.0 \times [(50 - M)/100] \quad (3)$$

where:

M = moisture removed in air drying, % (on as received basis).

8.1.3.5 Place the sample in a container as described in 8.1.1 and proceed as in Method A.

8.1.4 *Calculations for Test Method B*

8.1.4.1 Calculate the moisture content as follows:

$$\text{Moisture Content, \%} = (A - B)/B \times 100 \quad (4)$$

where:

B = mass of the oven-dried sample, g.

8.1.4.1.1

This calculation gives moisture content as a percentage of as-received mass.

8.1.4.2 An alternative calculation is as follows:

$$\text{Moisture Content, \%} = (A - B)/B \times 100 \quad (5)$$

8.1.4.2.1

This calculation gives moisture content as a percentage of oven-dried mass.

8.2 *Ash Content Determination*

8.2.1 *Test Method C*

8.2.1.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.1.2 Place a part of or all of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.1.3 Remove the cover and place the dish in a muffle furnace. Gradually bring the temperature in the muffle furnace to 440 °C ± 22 °C and hold until the specimen is completely ashed (no change of mass occurs after at least 1 hr. period of heating).

8.2.1.4 Cover with the retained aluminum foil cover, cool in a desiccator, and determine the mass to the nearest 0.01 g.

8.2.1.5 This test method should be used for geotechnical and general classification purposes.

8.2.2 *Test Method D*

8.2.2.1 Determine the mass of a covered high-silica or porcelain dish to the nearest 0.01 g.

8.2.2.2 Place a part of or all of the oven-dried test specimen from a moisture determination in the dish and determine the mass of the dish and specimen to the nearest 0.01 g.

8.2.2.3 Remove the cover and place the dish in a muffle furnace. Gradually bring the temperature in the muffle furnace to 750 °C ± 38 °C and hold until the specimen is completely ashed (no change in mass of the sample after further drying periods in excess of 1 h).

8.2.2.4 Cover with the retained aluminum foil cover, cool in a desiccator, and determine the mass to the nearest 0.01 g.

8.2.2.5 This test method should be used when peats are being evaluated for use as a fuel.

8.2.3 *Calculation for Test Methods C and D*

8.2.3.1 Calculate the ash content as follows:

$$\text{Ash Content, \%} = (C - 100)/B \quad (6)$$

where:

C = mass of ash, g, and

B = oven-dried test specimen, g.

8.3 *Organic Matter Determination*

8.3.1 *Calculation*

8.3.1.1 Determine the amount of organic matter to the nearest 0.1 % by difference, as follows:

$$\text{Organic matter, \%} = 100.0 - D \quad (7)$$

where:

D = ash content, % (nearest 0.1%).

9. Report

9.1 Report the following information:

9.1.1 Identify sample: project, boring or location, depth, and method used in sampling.

9.1.2 Results for organic matter and ash content, to the nearest 0.1 %. Use Practice D6026 to determine significant digits

9.1.3 Furnace temperature used for ash content determinations.

9.1.4 Whether moisture contents are by proportion of as-received mass or oven-dried mass.

9.1.4.1 Express results for moisture content as a percentage of as-received mass to the nearest 0.1 %.

9.1.4.2 Express results for moisture content as a percentage of oven-dried mass as follows:

(a) Below 100 % to the nearest 1 %.

(b) Between 100 % and 500 % to the nearest 5 %.

(c) Between 500 % and 1000 % to the nearest 10 %.

(d) Above 1000 % to the nearest 20 %.

10. Precision and Bias

10.1 *Precision*—Test data on precision is not presented due to the nature of the soil materials tested by this test method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program.

10.1.1 The Subcommittee D 18.22 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

10.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11. Keywords

11.1 ash content; moisture content; organic soil; peat; percent organic matter

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (07) that may impact the use of the standard.

(1) In 8.1.1.2 changed 4.1 to 7.1.
(2) In 8.1.3.2 changed 4.1 to 7.1.
(3) In 8.1.3.4 added (on as received basis) to end of sentence.
(4) In 8.1.4.1 add "mass of the" to B.
(5) In 8.2.1.2 added "to the nearest 0.01 g " to the end of the sentence.
(6) In 8.1.2.2 added "mass of the" to A.
(7) In 8.2.1.3 In sentence 2 add "at least 1 hr" to sentence.
(8) In 8.2.1.5 removed "all" in sentence.
(9) Changed D18.06 to D18.22 in Section 10.1.1
(10) In 11 changed "%" to "percent".
(11) In 7.1 deleted "rubber" from sentence.